PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

MARCH, 1939

A. PRESCOTT FOLWELL, Editor — VOL. 70. NO. 3 — W. A. HARDENBERGH, Asso. Editor

Contents

EDITORIAL 19

HIGHWAYS AND STREETS:

Paving and Sewerage Problems of the N. Y. World's Fair. *By Charles Baldwin* 9
Tar-Soil Stabilized Bases for Streets. *By C. H. Olmstead* 14
A Solution of the Street Maze Problem 18
Traffic Lines Cast in Color 20
Testing a Bridge by Loading with Water 20
How to Maintain Highways and Streets. *By W. A. Hardenbergh* 32

SEWERAGE AND SANITATION:

Sewer System and Treatment Plant for Town of 500 Built by WPA 16
The Many Bases for Sewer Rentals 20
A Sewage Aeration Ditch 20
Small Clam Shell Bucket Reduces Cost of Catch Basin Cleaning. *By Robert L. Anderson* 21
Refuse Disposal Practices in Two Cities 22
The SEWERAGE DIGEST 28

WATER SUPPLY AND PURIFICATION:

Water Supply for the New York World's Fair 12
Can a Too-Deep Well Be Refilled? 20
Chemical Terms and Conversion Factors 22
Testing Wells for Draw-Down 23
Reducing the Alkalinity of Well Waters 23
The WATERWORKS DIGEST 24
Liability for a Curb Box Above Grade 44

DEPARTMENTS:

Keeping Up With New Equipment 47
Readers' Service Section 52
The Engineers' Library 54

TIMEWASTERS

Spring Greetings:

We did remember to include the answers to our two church-type timewasters last month. They appeared on page 49 of the February issue. No one checked in with the three-7 problem. Simple! (7 plus 7) divided by 0.7 gives 20. Answers are still coming in on that square lot and tree problem. Mr. Robinson of N. D. says it took a whole lot of juggling of "our more or less unknown friends *a, b, c, and d*"; Mr. Vinson practically fractured his typewriter with this one. finally arriving at .0733852832 acre; and Mr. Brady also sent in a fine solution.

Mr. Wheeler writes in to say that " 'Taint been so cold this winter; but remember the time when the Fahrenheit and Centigrade thermometers read exactly the same and the Reaumur read minus 32?" He goes on to say it sometimes gets twice as cold as that; been reading the Satevepost, eh? Well, maybe some of the topnotchers can tell us how cold it was, and then how cold twice as cold was.

That problem in the February issue didn't seem hard to some. Unfortunately we've mislaid some of the replies (if you could see our desk, no wonder). Mr. Blunk says 9 chords, each subtending 10°; length of each chord 999 ft.; and radius 5729 ft. Mr. Wheeler says 9 chords, each subtending 5°, length of each chord 19 ft. and radius 109 ft. How about it, gentlemen?

Delightful letter from Mr. Vinson taking Mrs. Houtman's side of the controversy re grandpa's clock (see January issue). Sorry that our space is so limited that we can't give it here in full.

How About Some Digits?

Arrange the ten digits (0 through 9) to form numbers which will add up to 100, no more, no less, using each digit only once. *Johns-Manville.*

And Some Spheres, Too?

A 2-inch sphere is placed in a cubical box which has sides 2 inches long. What is the diameter of the spheres that can be placed in each of the eight corners of the box, just touching three sides of the box and just touching the sphere? *E. M. Brady.*

A Libel on the Scotch:

A party of 37 Scotch folks are planning to see the World's Fair. They have collected the adequate sum of $13.80 by assessing each man 50 cents, each woman 25 cents and each child 10 cents. How many of each are there? *John Bevan.*

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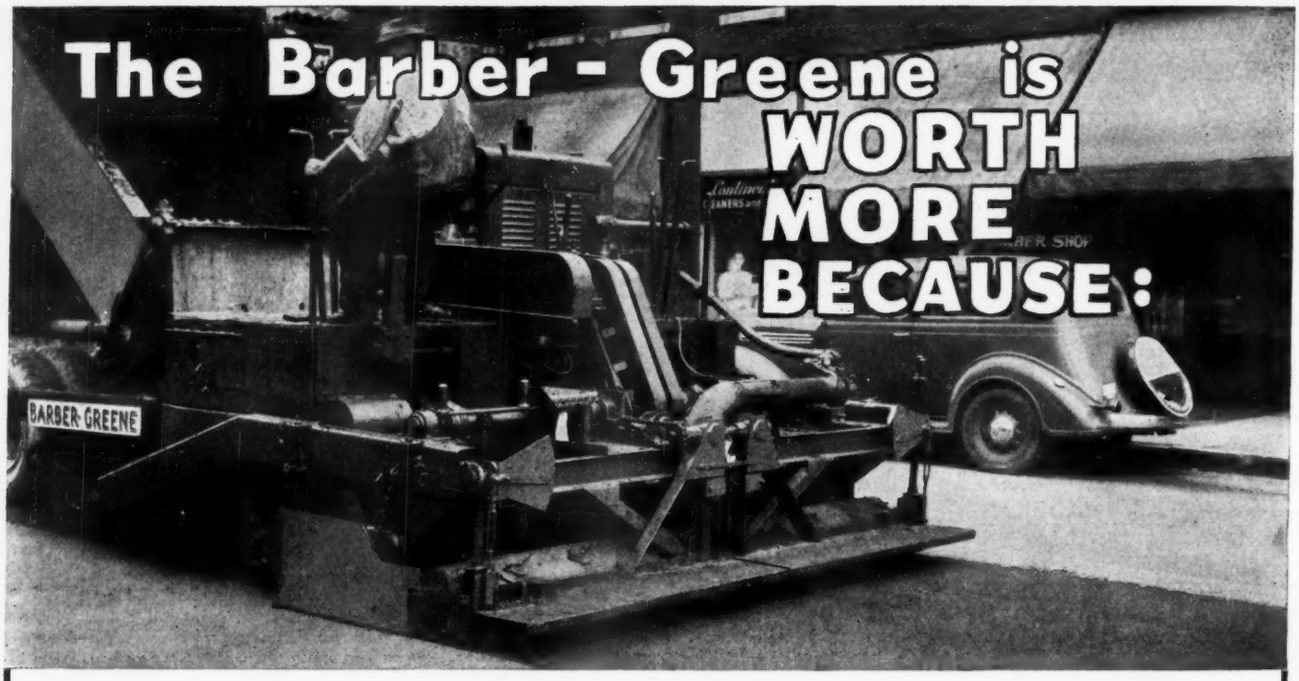

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Loosely struck off material is bound to compact more in the thicker mat portions. The Barber-Greene automatically puts all of the COMPACTED material needed into the low spots—thus retaining the level surface under rolling and traffic.

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Laying the parking field pavement. Trylon and perisphere in background

Solving Paving and Sewage Problems at the New York World's Fair

By CHARLES BALDWIN

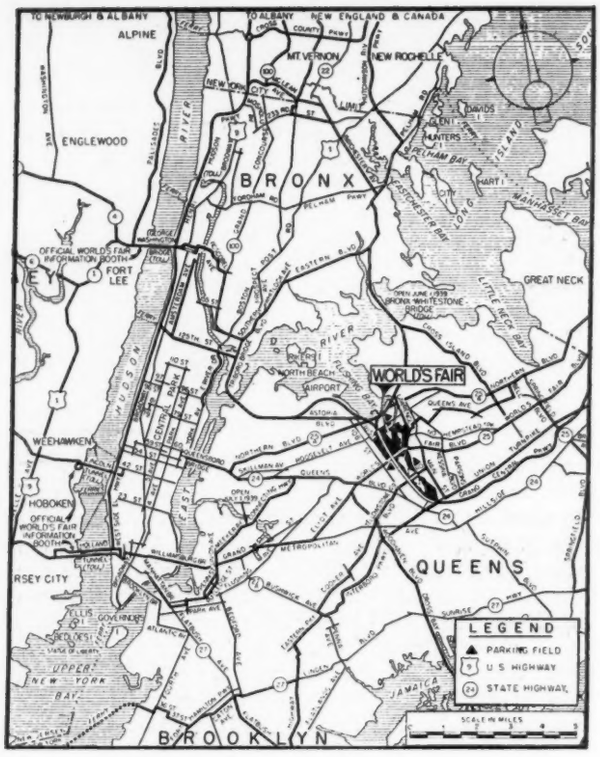
INCORPORATION of the New York World's Fair in the spring of 1936 created a thousand pressing problems for the city of New York—and, more particularly, for the Borough of Queens, since it was immediately apparent that the site of the fair would, in all probability, be "somewhere in Queens." A large fair —and New York had never promoted a large fair— called for a thousand acres of undeveloped land, at or near the geographical center of the city, served by adequate transportation lines. A glance at the map showed that Flushing Meadow in Queens is at the exact geographical center of the city, 20 minutes by rail and 30 minutes by motor car from midtown Manhattan. And so Flushing Meadow, crossed by the Long Island R.R., by subway, "el," bus and street car, and skirted by the Grand Central Motor Parkway, was selected, almost without debate, as the site of the New York World's Fair which will open on April 30, 1939, in commemoration of the 150th anniversary of the inauguration of George Washington as President of the United States.

This settled, development and servicing of the site became a rush job involving a wide range of engineering and construction problems, due, in part, to the peculiar characteristics of the site, a 1,200-acre marine swamp, built up of organic clays and silts, and extending 60 to 80 feet below the surface, the surface itself being only one or two feet above the mean high tide level.

For fifty years this swamp—drained by Flushing River, a sluggish tidal stream which twisted back and forth across the meadows—had been used by the city as a refuse dump. During that time an accumulation of over 50,000,000 cubic yards of refuse had piled up, at one point to a depth of 125 feet, over an area of 340 acres along the western boundaries of the swamp.

To secure the use of this dump, Fair officials entered into an agreement with the city that the city, as part of its contribution, should grade and improve the area with a view to converting it, after the Fair, into a permanent park. Working three shifts, five days a week, the Park Department did this in 9 months, moving and leveling 7,000,000 cubic yards of ashes and filling all low-lying areas to an elevation sufficiently above the water level to allow planting. Experience soon proved that a cover four feet deep was sufficient to support heavy trucking without inducing mud waves. On this blanket, 750,000 cubic yards of topsoil was spread, together with a million yards of meadow mat dredged from Flushing River to form two lakes, one 4,500 feet long and the other 2,500 feet long.

At the same time the office of the Borough President of Queens began the construction of two marginal storm sewers, one along the west and the other along the eastern boundaries of the Fair grounds. The eastern and longer of these two sewers extends from the cloverleaf



Map showing location of World's Fair in Queens.

intersection of Union Turnpike and Grand Central Parkway in Queens Village to Flushing Bay, a distance of 15,822 feet. This sewer begins as a monolithic section of reinforced concrete 12 feet wide and 8 feet high inside measurement, and ends as a three-barrel sewer, each chamber 18.5 feet wide and 10 feet high, with an over-all measurement of 66 feet 10 inches. The western sewer, a two-story affair, begins at Horace Harding Boulevard and 108th Street, drains Forest Hills, Kew Gardens, Elmhurst, Woodside and Queens Boulevard back to the ridge, and empties into Flushing Bay 900 feet west of the boat basin, a distance of 9,275 feet. It was constructed on two levels because the Forest Hills sewer lay on high ground and the Queens Boulevard trunk sewer at a much lower level. These elevations were maintained after the two trunks were joined to save on the cost of excavation, a deep narrow cut—at one point on 111th Street in Corona reaching a depth of 42 feet—serving as well as, or better than, a wider cut. Beyond 111th Street the three chambers are leveled off, the two lower chambers being brought around to the outside and the upper chamber stepped down. The sewer enters Flushing Bay as a four-barrel section, each barrel 10.5 feet wide and 9.25 feet high, with an overall width of 48 feet.

Skirting the marsh both sewers are laid on creosoted timber piles, driven to a depth of 105 to 110 feet, a row of seven piles to every four feet of sewer length, with batter piles to brace the sides. Where the ash fill was thin, a hole was punched in the blanket with a steel spud. The spud was then removed, a pile lowered into the hole and the hammer placed on top of the pile. A light tap, and pile and hammer would often drop as much as forty feet as the pile passed through the silt. Not until the pile penetrated the underlying sand 60 to 80 feet below the surface would there be any real resistance. It is interesting to note that once the pile entered the sand, should driving be discontinued, though only for an hour, the pile would "freeze" in the silt and fill, and as many as fifty blows might be required to produce further penetration.

With the conquest of the swamp under way, attention turned to the problem of transporting 60 million visitors to and from the Fair grounds in 185 days—an estimated average of 324,000 visitors a day, with a peak of 600,000. Stated in terms of "passengers carried" this means 120 million rides in 185 days, an average of 648,000 rides a day, with a peak of a million or more. And these figures, based upon the experience records of other fairs, do not include the 35,000 Fair and concessionaire employees.

In other words, provision must be made for a city with an anticipated daily maximum population of 600,000 to 700,000, with transportation facilities for moving every man, woman and child in and out of the city seven days a week from April 30 to October 31. And this load must be superimposed upon the already existing—indeed, due to the Fair, greatly increased—regular traffic of the city.

Since the Fair grounds, though geographically in the center of the city, are relatively remote from the centers of population, it could safely be assumed that very few visitors would arrive on foot. The vast majority—say, a midsummer peak load of 100,000 an hour—would use one or another of the four low-fare railroad, subway or elevated systems, leaving 60,000 an hour to arrive by bus, street car, taxi, ferry and private car.

It was estimated that upwards of 50,000 private cars, 10,000 taxis and 1,500 buses, together with thousands of trucks and delivery vans, might, in a single day, converge upon the Fair grounds, creating—unless properly distributed—a traffic problem of the first magnitude.

Since 70% of those visiting the Fair will come from out of town, it was agreed that everything possible must be done to keep the routing of traffic as simple as possible, avoiding the more congested areas without leading the out-of-town motorist through tortuous by-paths away from the city's centers of interest.

A schedule was planned to divide the work between the state, the city of New York, the Borough of Queens and the WPA. The state agreed to construct two new bridges across the Flushing River, at Horace Harding Boulevard and at 69th Road, both of which bisect the Fair grounds; to install three permanent bridges over the Grand Central Parkway, at Northern Boulevard, at Roosevelt Avenue and where the Long Island R.R. crossed the Parkway; and to build a boat basin at the south end of Flushing Bay with an access road to the

Fair Grounds. The city undertook to bring an extension of the Independent (city-owned) Subway into the Fair grounds and to construct a $2,200,000 double-leaf bascule bridge across Flushing River at Northern Boulevard. Meanwhile work was being rushed on the new Whitestone Bridge across the East River, allowing just 22 months to complete a $16,000,000 suspension bridge, with a main span of 2,300 feet and foundations sunk 100 to 163 feet below the water level.

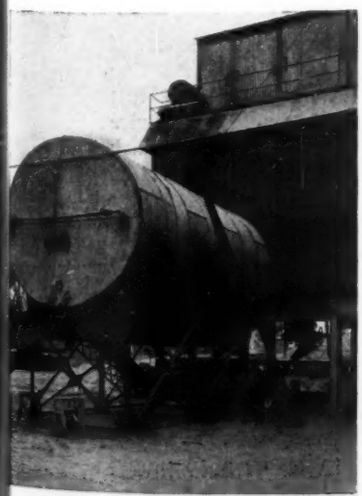
As to the work undertaken by the Works Progress Administration, first in interest and size comes the North Beach Airport. This project called for moving 16,600,000 cubic yards of cinders from Riker's Island by truck across a WPA-constructed trestle to fill 228 acres in Flushing Bay, raising the grade of the existing field to 11 feet above mean low water. On this fill the WPA erected a seaplane base administration building with a landing platform in the Bay, a land plane administration building, seven land plane hangars, four large runways, with taxi runways to connect all the main runways and the seaplane base—a project that has kept an average of 10,000 WPA workers busy 24 hours a day for upwards of two years.

Equally important, and more directly occasioned by the Fair, were the seventy-some WPA highway and sewer projects sponsored by the Borough President of Queens and the repaving of the upper level of the Queensboro Bridge under the sponsorship of Mayor La Guardia.

Taking the last first, specifications for the Queensboro Bridge called for a new roadway of non-skid concrete to replace the old one which for years had provided a wet-weather hazard for motorists. Originally planned for completion on April 30, 1939, the job was completed in just half the allotted ten months at a cost of $461,000 as against an original estimate of $673,500. At the peak of the work, 1,100 men were employed.

Of the highway projects sponsored by Borough President George U. Harvey of Queens, three were of outstanding importance — Union Turnpike, Woodhaven Boulevard and the 62-acre parking field north of the Fair grounds.

The parking field, a rush job, required a peak of 1,900 men, working two shifts, to drain, grade, pave, landscape and fence an area of 350,000 square yards, spreading 150,000 cubic yards of fill, installing 1,420 feet of concrete sewer pipe, 6,600 feet of steel conduit and 3,000 feet of concrete duct; erecting 4 flood light towers, building a dozen bus platforms and toll booths, and laying 291,000 square yards of 2-inch bituminous concrete on a 3½-inch penetrated base of ⅜-inch stone chips to provide parking facilities for 12,000 automobiles.



The Barber-Greene bituminous mixer set up for supplying the parking field mixture.

This area, which is the equivalent of twenty-five miles of 20-ft. wide pavement, was paved with bituminous concrete supplied by a Barber-Greene bituminous mixer, operating as a central plant. The mix was a dense graded aggregate (¼-inch, with 50% fines) using RT-11 tar. A Barber-Greene tamping leveling finisher placed the surfacing for the entire area.

The Perisphere and Trylon dominate the N. Y. 1939 Fair

Material was brought in by boats to the mixing plant site, which was about 1½ miles from the parking lot. From the boat, clamshells unloaded aggregate via belt conveyors to the dryer. After drying, the stone was screened and stored in a large three-compartment bin. From there it was carried by conveyors to the aggregate hopper of the Barber-Greene mixer.

The mixer was set up on piles so that the 8-ton trucks could drive in under the pugmill discharge to receive their loads and be on their way. When the truck was filled, the mixer operator closed the discharge control gate, which eliminated spillage of material but did not stop the continuous mixing operations.

The mixer was set up to produce 120 tons per hour and the finisher, laying a 12 ft. width, operated at a speed of 27 ft. per min. The general practice was to lay a strip of 1,200 feet long at one time, and then return for the next strip. Due to the tamping action it was possible to secure a very good matching of joints—in fact, the joints were scarcely discernible after rolling.

As an interesting sidelight—the hurricane struck Long Island while the job was in progress. The water was 8 to 10 feet deep in some places, and it caused great havoc with much of the equipment. Three 10,000 gallon tanks were raised off their concrete foundations, breaking all pipe connections, including some 6" dia. pipe. Drums and other pieces floated as much as 2 miles away from the job. The mixer was not affected by this water, however, and production was resumed in remarkably short time. That section of the parking lot which had already been paved, did not seem to be harmed by the unexpected submersion.

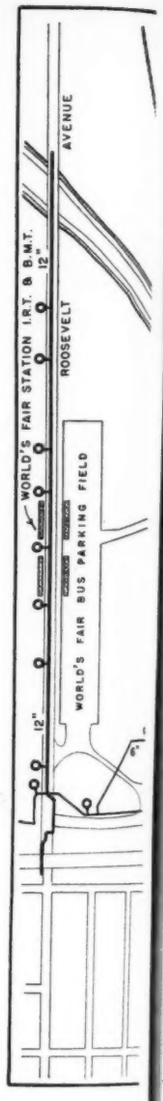
Union Turnpike was the first of the major World's

(Continued on page 45)

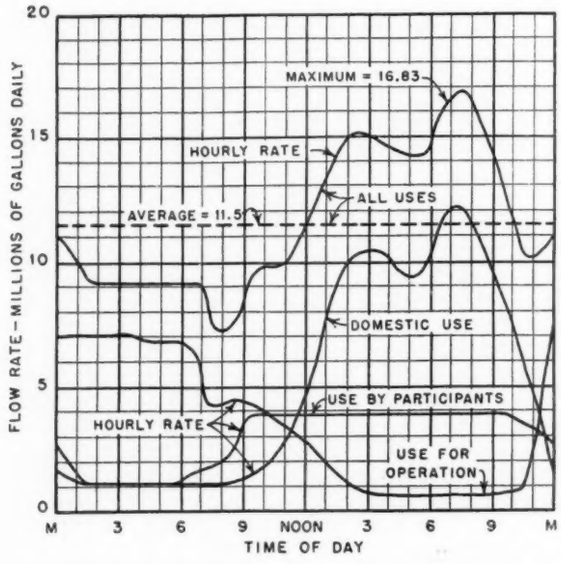
Water Supply for the New York World's Fair

PROVIDING a water supply for New York's World's Fair presented a number of problems of both design and construction which are of considerable interest to waterworks men. The estimate of the amount to be provided could be based only slightly upon data derived from municipal experiences. At the time of designing, little was known about who the exhibitors and concessionaires would be and less about their probable water demands. Drinking fountains, restaurants and toilets there were some data available for, but the supply needed for display fountains was indefinite but probably would be great. Scores of acres of new lawns, shrubbery and trees, newly planted on a more or less porous fill, needed to be irrigated. There were municipal data for street and sewer flushing and fire protection, but how much must be allowed for leakage in view of the fact that the mains would be laid with all speed possible in fills that had not stopped settling, while the streets were under continuous use by heavy trucks, foundation piles were being driven by the thousand on all sides, sewers were being built, full-grown shade trees were being planted?

One of the most difficult construction problems was that of foundation. The site was two square miles of salt marsh, through which meandered a tidal river, which had been used for years as a dumping ground for ashes, garbage and rubbish, estimated to total 50,000,000 cu. yd. and rising at places 90 ft. above tide level, and which had settled into the mud 25 to 50 ft. in some places, while at others the mud was uncovered. Depths to sand adequate for supporting foundations were as much as 90 ft. Some of the pipes were laid in new fill occupying the original river channel, the route of which across the fair grounds was changed. Where the fills were least consolidated, the pipes were supported by piles and heavy stringers, but even then general soil movements caused leaky joints; which also were caused by heavy trucking over freshly filled trenches without any pavement to protect them, by construction of sewers and drains close to and across mains immediately after laying. An additional difficulty was the number of angles in the alignment of the mains, necessitated by the irregular layout and detours around the 10,000 tree holes; which angles received little support from the ash fill.



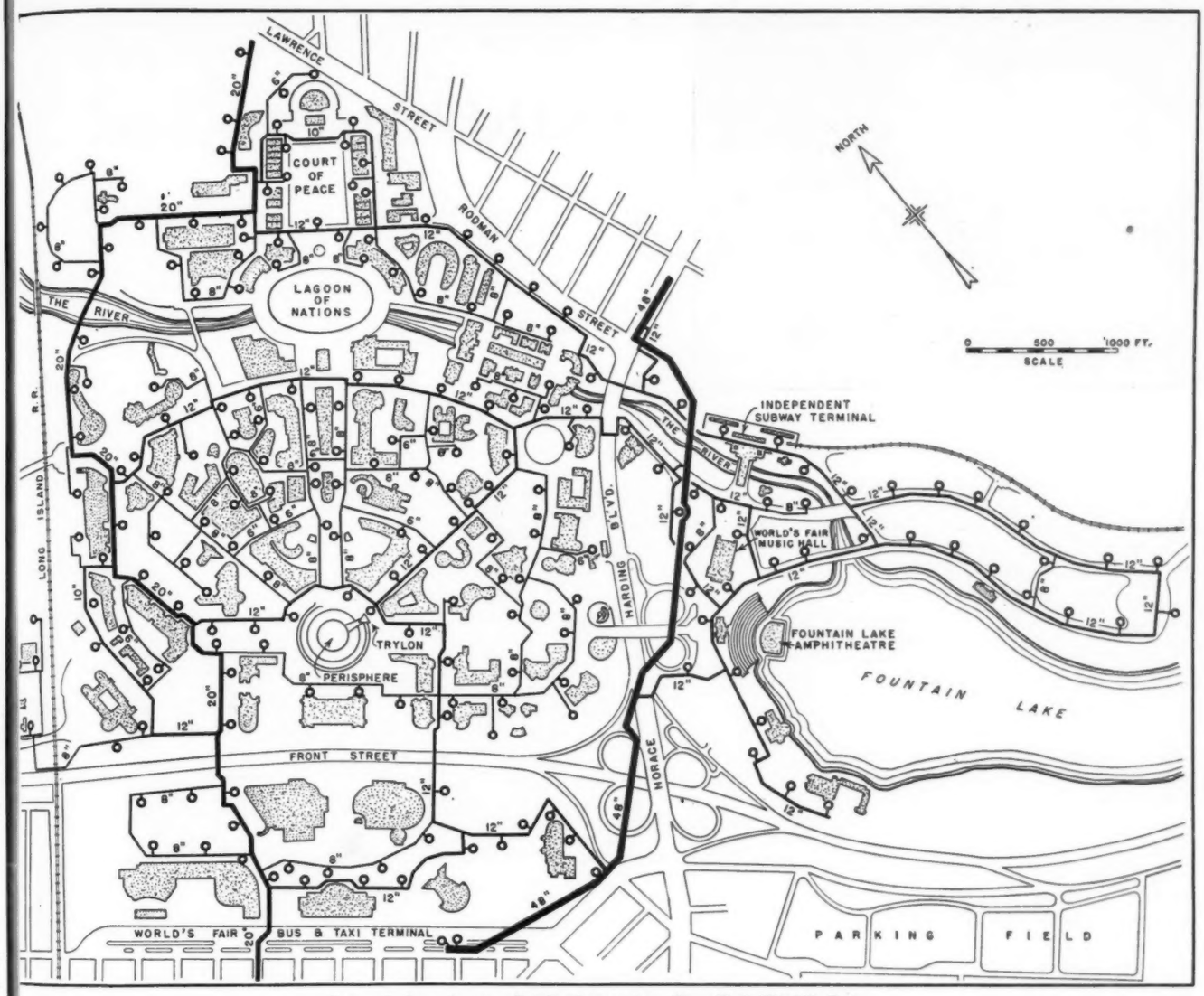
In spite of this, all the main lines have been laid and in use for nine months without any serious developments. A few lines have been replaced where major soil movements prevented satisfactory maintenance; defective connections have been remedied and additional anchorages at angles provided where necessary. This preliminary use during the construction of the fair has given the advantage of revealing weak points, the correction of which gives reasonable assurance that the mains will serve satisfactorily during the fair.



Estimated water connsumption at New York World's Fair Grounds.

In selecting the kind of pipe for use, consideration was given to the unstable foundation, to the fact that much of it was for temporary use only, and to keeping combined constructing and operating costs at a minimum. The two largest mains form a permanent part of the city's transmission system—a 48″ riveted steel line built by the city and a 20″ cast iron and steel one built by the fair. Certain other lines are to remain in service when the fair grounds are turned over to the Park Dept., for use as a park and required the approval of its officials. Of the thirteen miles of mains, 13% is cast iron, 3% is ½ in. steel, 6% is light gauge steel, and 78% is asbestos cement. Light gauge steel was used during the earliest construction for immediate irrigation, but does not permit adding service connections readily.

Estimates of capacity required were based on the experiences of the 1933 Chicago Fair, adjusted to the character, area and expected populations at the New York Fair. The estimate so made is shown in the accompanying table. The total consumption on a maximum day with an attendance of 800,000 was estimated at 12



General plan of water distribution system, New York World's Fair.

Since this map was drawn, an 8-inch main has been extended south of Fountain Lake from the 12-inch main. Also not included in this map is the system of mains provided by the World's Fair Corp. for the district north of Roosevelt Avenue.

mg, and the maximum hourly demand 17 mgd. It is planned to confine the majority of water-using operations—irrigation, street and sewer flushing and floor scrubbing—to the hours of 12 to 7 A.M. For fire fighting, pipe sizes are designed to provide a 3 mgd rate while meeting the other demands, without reducing street level pressures below 45 lb., or supply 8 mgd irrespective of pressure in case of a major conflagration. Hydrants, 250 in number, are placed at intervals of not more than 300 ft. Water conservation is sought through use of water saving devices in air-conditioning equipment and requiring recirculating pumps for all except the very smallest fountain displays. (However, fire line and sprinkler connections and small sized outlets are unmetered.)

Estimated Water Consumption for New York's World's Fair

Classification	*Average Daily Rate*	*Maximum Hourly Rate*	*Consumption Rate During Maximum Hour*
	m.g.d.	*m.g.d.*	*m.g.d.*
Comfort stations	0.69	4.80	4.80
Drinking fountains	1.08	1.08	1.08
Kitchens and concessions	0.83	6.50	6.50
Irrigation	1.68	4.80	...
Street flushing	0.15	0.75	...
Floor scrubbing	0.02	0.06	...
Sewer flushing	0.30	1.50	...
Transformer cooling	0.15	0.15	0.15
Display fountains	0.80	1.20	1.20
Miscellaneous	1.50	2.50	2.50
Waste and leakage	0.40	0.60	0.60
Total	7.60	...	16.83
Allowance for fire protection	...	2.88	2.88
Total	7.60	...	19.71

All water to be used in the fair is delivered at its boundary through city mains, Catskill water being furnished at pressures varying from 75 to 107 lb. per sq. in. The quality is protected by sterilizing all mains prior to regular operation, and prohibiting cross-connections, and construction of private piping by unauthorized persons.

The possibility of obtaining a reserve supply from wells was investigated but the yield obtainable was too small to justify the cost.

The above information and illustrations were derived from a paper before the American Water Works Association by Benjamin Eisner, Chief Sanitary Engineer of the Fair, through the courtesy of the Association.

Widening the roadway

Building Tar-Soil

By C. H. OLMSTEAD

Consulting Engineer, Tarvia Department, The Barrett Company

ALBERTVILLE, Alabama, a town of about 2700 population, is the trading center for the south central part of Marshall County. This city is rather long and narrow, extending along U. S. Highway No. 241, which was about the only paved street in town; and even on this street, beyond the business section, where it was paved from gutter to gutter, a width of about twelve feet between the pavement edge and the gutter on each side of the paved highway had not been paved.

The unpaved streets consisted largely of natural soil, which was a sandy loam. To some streets chert or slag had been added in quantities which varied but in no case were sufficient to provide a stable base satisfactory for surface treatment.

As the town had a considerable unemployment problem, a W.P.A. street construction program was set up. Owing to the high cost of material for street paving, it was decided to stabilize the existing material on the streets with tar, constructing a tar-soil stabilized base four inches thick, followed by a tar surface treatment.

A street construction project including three streets was planned, consisting of about 4,000 square yards. Four samples of the material in these three streets were secured and forwarded to the Soils Division of the Research Department of The Barrett Company for study.

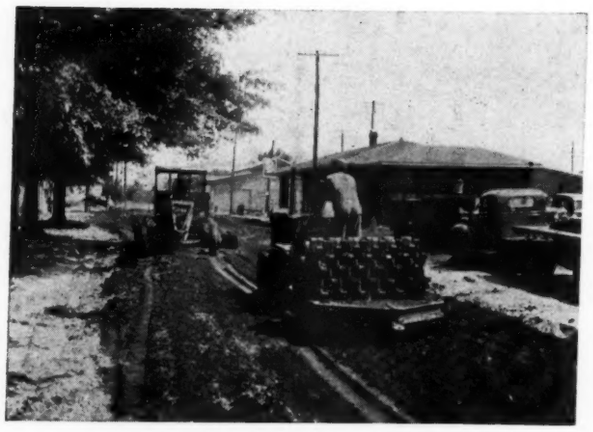
Soil Studies

This material, it was found, consisted largely of a sandy loam with varying percentages of pebbles and coarse granular materials. The soil was sandy in character, and the percentage passing the No. 270 sieve consisted essentially of silt of a non-plastic character. It is seen from the following sieve analyses that their gradation showed considerable variation, but all were very similar in the gradation and character of the material passing the No. 10 sieve.

Table I

Material from	*McCord Ave.*		*Ober Ave.*	*Jackson St.*
Passing 1⅞" sieve	100%			99.1% (a)
Passing 1¼" sieve	96		100%	95
Passing ¾" sieve	88		99.5	90
Passing ⅜" sieve	80	100%	99	82
Passing ¼" sieve	74		98	78
Passing No. 4 sieve	70	99.8	97	76
Passing No. 10 sieve	60	99.5	95	72
Passing No. 40 sieve	51	98	92	67
Passing No. 60 sieve	40	73	60	48
Passing No. 80 sieve	34	57	39	38
Passing No. 200 sieve	24	43	17	25
Passing No. 270 wet sieving	22	41	15	23

(a) Two large stones, 3" in diameter retained on 1⅞" sieve.



Compacting with a sheepsfoot roller

Table II—Grading of Portion Passing No. 10 Sieve

Material from	*McCord Ave.*	*Ober Ave.*	*Jackson St.*
Passing No. 10 sieve	100%	100%	100%
Passing No. 40 sieve	85	98	92
Passing No. 60 sieve	67	68	67
Passing No. 80 sieve	57	49	53
Passing No. 200 sieve	40	31	35
Passing No. 270 wet sieving	37	29	32

(a) Average of two samples.

On the basis of these it was recommended that regular Tarvia retread, a tar having a specific viscosity, Engler, at 50°C. of from 16 to 22, be used as the stabilizing material in the amount of six per cent, by weight, of the material passing the No. 10 sieve; that the soil be moistened before adding and mixing with the tar, and that, at the time of compacting, the mixture contain approximately nine to ten per cent of moisture, based on the dry mixture of soil passing a No. 10 sieve.

Construction Method and Equipment

In order to utilize as much labor as possible, it was decided to use a concrete paving mixer for the mixing of soil, tar, and water; and a Koehring 27 E Paver was rented from a contractor. A truck distributor heated and delivered the tar from the tank car to the supply tank. A tank for the tar was mounted on a wagon, which was equipped with measuring tank, a half steel drum fitted with a float gauge, gas engine, and pump. The pump transferred the tar from the storage tank to the measuring tank and from there to spray nozzles in the mixer drum. This assembly was fastened to the side of the paver and moved with it. Water was furnished

Stabilized Street Bases

Streets without any previous roadway improvement were surfaced in Albertville, Ala., by mixing tar with the soil present, using a concrete mixer for some, road mix for other streets, to make a base 4" thick, which was covered with a tar surface treatment. Good, low-cost results were obtained on 40,000 square yards.

to the mixing drum from the paver water tank, which was supplied from fire hydrants by fire hose. In starting the work on each street with the mixer, soil was excavated for the required width and depth for about thirty linear feet where the work was to begin. This soil was loaded into trucks, hauled to the other end of the street, and dumped alongside the mixer.

Other equipment available for the work included a power grader, crawler type tractor, sheep's-foot roller, and ten-ton power roller.

Field Control

By the time construction work started, the program was greatly extended, and the street selected to be paved first was one for which no grading tests had been made. It was realized that for satisfactory work, owing to the variable quantity of coarse aggregate in each street, the quantity of tar must be adjusted and a volumetric control of soil and tar established for use in the paving mixer.

A representative cubic foot of the soil from this street was measured out and weighed. By quartering several times, a small sample was obtained from which the percentage passing the No. 10 sieve was ascertained and moisture content determined.

The following results were obtained:

Weight per cubic foot, lose damp	90 pounds
Per cent of moisture	7.54
Weight loose dry	83.22
Per cent passing No. 10 sieve	55
Per cent of tar, based on per cent passing No. 10 sieve	6
Tar required per cubic yard	8.05 gallons
Tar used	8 gallons

Giving the road the final dressing

Tar surface treatment completed

It was found that the field control of moisture for mixing was unnecessary, as an excess of water was required in order to empty the mixer drum.

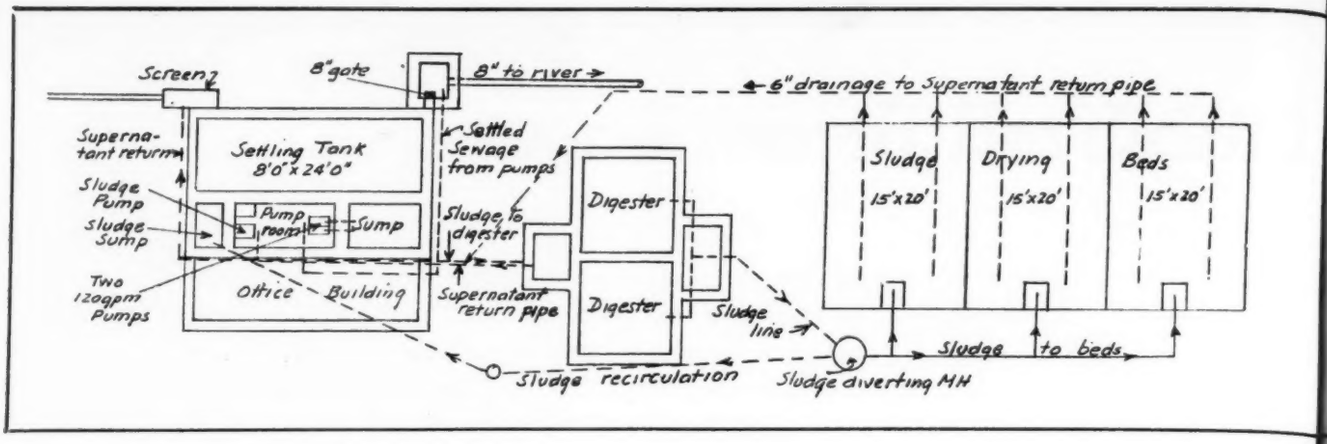
Soil samples were taken of all the streets to be stabilized. These samples were quartered to the desired quantity, dried, and the percentage of soil passing the No. 10 sieve determined. The quantity of tar per cubic yard was determined as previously described. This gave complete information for the field control and worked out very satisfactorily.

Construction

The streets were scarified to a depth of about six inches and windrowed to the sides. The loose soil was loaded into wheel-barrows with shovels and dumped into the mixer skip. One cubic yard of soil was used per batch. A spread of about six square yards for four-inch compacted thickness was obtained per cubic yard of mix. The amount of tar per batch was reduced by one and one-half gallons to provide for a tack coat of one-quarter of a gallon per square yard, to be applied to the compacted base.

Considerable more water than the optimum was required in order to empty the mix from the mixer drum. With this excess moisture content, it was necessary to permit the mix to dry to approximately the optimum before spreading and consolidating with the sheep's foot roller. The surface of the mix was then bladed to remove the tamp marks and the surface given a final rolling with a ten-ton roller.

(Continued on page 45)



Sewer System and Modern S for Town of 500 B

TO SERVE the village of Roscoe, a fishing and summer resort in the Catskill Mountain section of New York State, a sewer system and sewage treatment plant has been constructed, using WPA labor. Roscoe is situated on the Beaverkill and Willowemoc Rivers, two of the country's famous trout streams, and the elimination of pollution from these streams was one of the important reasons for constructing the system and treatment plant.

The sewer system involved about 11,000 feet of 8-inch and 10-inch sewer, laid at depths up to 17 feet and one crossing under a four-track railway. The treatment plant consists of a sedimentation tank with mechanical sludge removal apparatus, a separate digestion tank, chlorination of the tank effluent, and sludge drying beds. The population is about 500, and the design was based on a flow of 90,000 gpd. The total cost, including all WPA labor costs, engineering and equipment, amounted to about $26,000. The cost to the community for the system and treatment plant was approximately $15,000, the remaining $11,000 representing the cost for labor which was absorbed by the WPA. Primary treatment only was required because of the high degree of dilution in the river at all stages of flow.

The topography of the village, which is situated on a hill jutting out into the flat valley area, combined with the location of the railroad, made the layout of the system somewhat difficult. In addition, the flat grades of the valley section presented a problem of pumping or not pumping the sewage.

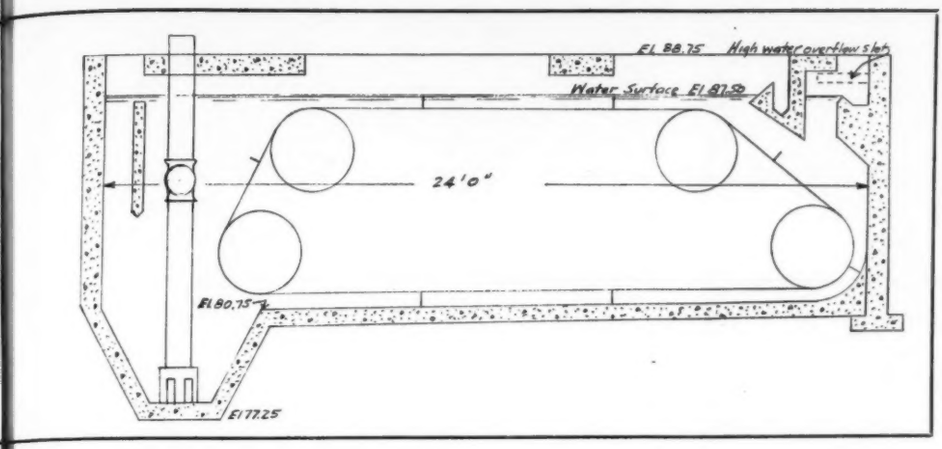
The first problem of location was solved by keeping the entire sewer system, with the exception of one branch line, on the village side of the railroad tracks. This avoided two crossings of the railroad through boulder and rock fills. One crossing was necessary to bring a branch line sewer through; this was made in original soil, under the fill, by jacking a corrugated pipe through and laying the sewer in the pipe.

The location, as planned, necessitated a cut from 15 to 17 feet deep, between the railroad and a steep bank, for a distance of about 400 feet. This was made through boulder-filled gravel, the lower two feet being in quicksand. Close sheeting was necessary, dirt had to be handled 4 to 6 times, and part of it moved 300 feet after removal from the trench. Progress was, of course, slow, and costs high, but not unreasonably so; in fact, this section could not have been done other than by hand excavation, and it is doubtful if the cost would have been less by any other method or by any other personnel.

This work and, in fact, most of the sewer construction, was done during the winter months, since that was the only time that labor was available. Gangs in the winter averaged 30 men; in the summer as few as 3 and at times none. The labor furnished by the WPA was of a high type and the foreman was unusually capable, with the result that good workmanship was obtained at reasonable unit costs. The safety engineer representing the WPA did excellent work. Despite the depth of excavation on the one section, and its proximity to the railroad, and the heavy traffic on the streets during construction, not a single man was injured on the entire job.

Another factor in design was the flat grades and the slight elevation of the valley floor above the river. A minimum grade of 0.4 ft. per 100 was established for the 8-inch line. Many of the buildings in town had very shallow basements, in order to keep out of the ground water. This permitted placing the sewer lines only four feet deep at the upper ends. At the plant site, ground elevation was 91.6; river low water level, 84.7; average high water level, 87.5; and extreme high water level, 92.6. The invert elevation of the sewer at the plant site was 87.5. In order to avoid pumping the sewage throughout the year, it was decided to build a gravity plant, even though the initial cost would be higher due to construction in ground water. It was estimated that with a gravity plant, pumping of the effluent would be needed only about 15 days a year.

A small town constructs a modern type of sewage treatment plant, with mechanical sludge collection, and unheated digestion. The entire plant was built with WPA labor at a cost comparable to contract



The cut on this page shows a section of the settling tank. The sludge collection apparatus is gasoline engine driven. The cut on the opposite page shows the layout of the plant, which was protected by a levee against high water.

Sewage Treatment Plant Built with WPA

Bituminous joints were provided for all sewers; in laying, two or three lengths were joined on the ground, and these connected in the trench. A check on infiltration showed practically no leakage, even though much of the line was in ground water.

The treatment plant consists of a manually cleaned screen; a single rectangular sedimentation tank, 8 feet wide, 24 ft. long and 6 ft. 6 ins. deep, equipped with Link-Belt sludge removal apparatus; a two-compartment unheated sludge digestion tank; and sludge drying beds. A Marlow sludge pump is used to convey the sludge to the digester, which was elevated to reduce construction costs; and two Marlow 120 gpm centrifugal pumps were provided to handle the effluent during high water periods. All of these—sludge collection equipment and pumps—were equipped with air-cooled gasoline engine drives. Electricity was not available at the plant, and it would have cost considerable to provide it. The use of air-cooled engines on the pumps complied with the requirement of two separate power sources for sewage pumps. All four engines were of the same make in order to facilitate repairs.

Provision was made so that when the river rises above the level of the sewage in the settling tank, a cut-off valve will be closed manually; the overflow from the settling tank then passes through an overflow slot into a pump sump. The two 120 gpm pumps draw from this sump and discharge into the outlet manhole beyond the valve. Computations and local experience both agreed that it required 18 to 24 hours for the river to rise sufficiently to flood the plant; therefore manual control was considered preferable to automatic control for closing the valve and starting the pumps.

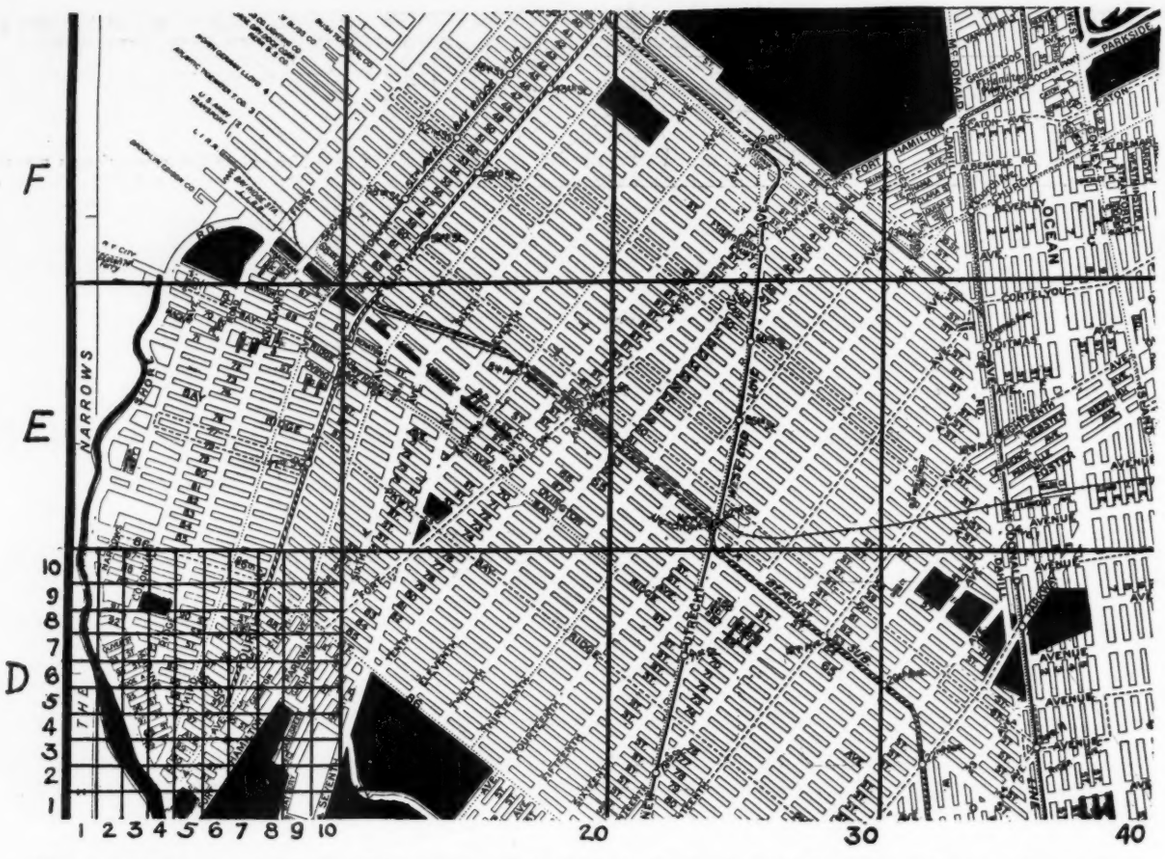
The bottoms of the twin hoppers of the settling tank are at elevation 77.25, which required excavation for the tank construction to a depth of about 8 feet below ground water level. The subsoil was a sandy gravel, and ground water offered considerable difficulty in construction. The side and end walls of the tank were built in trenches; the portion of the bottom ahead of the hoppers was then built. On this work, two trench pumps, the sludge pump and the two 120 gpm centrifugals managed to keep the water down. When construction of the hoppers began, this battery of pumps was unable to control the water, so the town fire engine was brought down, and with all six pumps working at capacity, the job was finished. Relief holes were left in the bottom of the tank to prevent the ground water lifting the slab.

The remainder of the construction work did not offer any serious problems, though with the number of men available, delays due to bad weather, etc., progress was slow. In fact, more than three years elapsed between the time the first dirt was turned, and the final finishing of the job. It is only fair, however, to state that the construction of additional lateral sewers primarily for work relief purposes was largely responsible for this long construction period.

The office building houses the pumping units on a lower floor, reached by steps from the office proper. On the main level is the office, laboratory space, a chlorinator room, and a comfort station for the adjoining baseball and sports field. The entire plant is protected against high water by a levee with top elevation 95.0. The sludge beds at elevation 92.0 are subject to some backing up of water into the underdrains during high water, which is not expected to cause damage. The office building is constructed of slag blocks, with a tar roof, and with insulating board finish on the interior.

The work was started under Frank Griswold, town supervisor; continued under his successor R. B. Twiss; and completed by Mr. Griswold when he was reelected to his former position. Fred Bullis acted as foreman throughout; Olney Borden as WPA engineer for the area was responsible for this phase of the work.

The digestion tank contains two compartments, each 10 ft. square, with a maximum depth of 16 feet, providing a total capacity of 5.8 cubic feet per capita for present population. Sludge is drawn from the bottom to 3 sludge drying beds, which are uncovered. Total sludge bed area is 900 sq. ft. Supernatant overflows are provided 3, 5 and 7 feet below the surface of the sludge. The digester is banked with earth to the top. Raw sludge may be diverted by valves to either of the compartments and sludge may be drawn from either. The tank is covered with a concrete roof. Gas is not collected but escapes through an elevated vent pipe.



Map of a small section of Brooklyn. The heavy line at the left is the N—S axis, which lies west of all parts of Greater New York except Staten Island (which is geographically a part of New Jersey). Each of the large squares is a square mile.

A Solution for the Street Maze Problem

GREATER New York was formed by the combination of many cities and villages, about a dozen being contained in the Borough of Brooklyn alone. In the case of this borough, each of these units had a street system laid out with entire disregard of those of adjoining units—most of them with complete lack of system within their own boundaries. These street systems have now been extended until they contact each other, and the street confusion probably exceeds that of any other city in the world—not even excepting Boston or London. Queens contains over 2,000 named streets; several streets change name as they pass from one of the old municipal units to another, and many names apply to two, three or even four different streets. Numbers increase going east on one street and going west on another. Manhattan Borough is not so bad, but even here 4th Street intersects 11th Street, Van Nest Place is the name of a part of one side only of Charles Street.

To find an address in any of these hodge-podges of streets is too difficult for the average man. There are thousands of miles of them, and to relocate, or even rename and renumber, many of them is impracticable.

A solution is suggested by Lee J. Mills, a resident of Brooklyn. His plan is based on the coordinate system. This has been used for house numbering in some cities, but his plan does not affect the house numbers, but would be appended to them. A north and south axis would be laid just west of the western limit of Brooklyn and Manhattan, and an east and west axis just south of Coney Island, in the ocean. The city would then be divided into square mile sections, and each of these into 100 squares 528 ft. to a side. These square mile areas would be numbered consecutively east from the N-S axis, and lettered consecutively north from the E-W axis; tenths of a mile being indicated by a second integer for the former, and by an integer before the letter in the latter. Thus 5D — 38 is 3.5 miles north of one axis and 3.8 miles east of the other. From this point, to reach 3F — 35 one would go (5.3 — 3.5 =) 1.8 miles north and (3.5 — 3.8 =) — 0.3 east = 0.3 west. These lines would seldom coincide with any street, but when one is less than 528 ft. in either direction from a desired address, finding it should not be difficult.

The coordinate designation would be appended to a house number—as: 1627 Broadway — 8L — 48: which is 11.8 miles north and 4.8 miles east of the axes. They would also be placed on lamp or other posts at all street corners making a trail that any one can follow, and find any address without map or street guide, providing he knows his alphabet and can count.

The system can of course be applied to any city, but would be unnecessary for one having the Philadelphia or century system of street layout, with house numbers beginning a new hundred at each intersecting street.

The Editor's Page

Springtime on the Highways—for the Maintenance Engineer

With most of the winter gone, we hope, the snow plows can be put away (though the plow manufacturers are praying for one more really good snowstorm). But this does not mean less work for the maintenance man, for springtime brings an abundance of different kinds. About the first of these is to get out on the roads and see how much damage to them the past winter has wrought.

Most of the damage will have been caused by water, though narrow snow plowing, with consequent concentration of traffic, may have been responsible for some break-ups. Now is the time for the superintendent or engineer to go over the highways very carefully and locate every break. A little later in the season, some of these will have dried out so that the cause of failure will be more difficult to locate. Therefore, while the ground is still full of moisture, every break should be marked and located by references so that it can be found later. Full notes should be made of every failure, with data on moisture and soil conditions, drainage status, apparent cause of failure, and remedies that appear to be needed.

Doing this will take time, which is too often a scarce article; but the time spent will be richly rewarded by a knowledge of what to do and how to do it. Inadequate drainage, both surface and subsurface, is without doubt the most important single cause of highway failures, no matter what the type of surface.

Also, bridges and culverts should be inspected to see that the winter or the spring floods have not damaged piers or abutments; that the stream has not eroded around footings; and that debris is not piled up where it will constrict the channel or be a fire hazard.

Meantime the mechanic should go over all the equipment and see that it is in shape for work, paying special attention to trucks and other vehicles, that have been doing hard, racking work during the winter. All should be oiled and greased and badly worn parts renewed. If it has not been done during the winter, applying a fresh coat of paint is worth while for several reasons.

These are only a few of the spring jobs that will keep the maintenance man from making any serious engagements for fishing trips or other seasonable pastimes.

Factors in Disposing of Household Wastes

Germany has organized very thoroughly the procedure of salvaging all waste materials that may be of value. Municipalities of more than 35,000 population are reported to be required to maintain constant sorting of their refuse in order to recover everything that can be put to further use. Garbage and food wastes are used for feeding hogs. Other waste material is sorted for valuables, and the residue utilized for agricultural purposes.

Japan sorts refuse carefully—what there is, for the Japanese are a frugal people. Scrap iron, waste rubber, old corks and old hats are remade into useful articles. Russia and Italy, also, have taken steps toward salvaging everything that can be used.

In the United States, it has been repeatedly demonstrated that such salvage operations rarely pay. Even the feeding of garbage to hogs is a precarious business from the profit and loss standpoint; and it is rarely a sanitary procedure. Probably it can not be justified in the great majority of cases on any basis. Sorting and utilization of waste has in no case that we know of been able to pay a living salary to the workers engaged in doing it, and nothing, of course, toward overhead. We can't avoid feeling that the best, most sanitary and generally cheapest method of disposal is the good old standby—incineration.

Another Way of Looking at Motor Vehicle Taxes

The taxes levied on motor vehicles during 1938 produced more than enough money to buy all the new motor vehicles—trucks, automobiles and motorcycles—sold in the United States in that year. Federal, state and local taxes on motor vehicle users garnered $1,525,000,000 in 1938, according to the American Petroleum Institute. There were 2,255,000 motor vehicles sold during 1938, the average price at the factory for passenger cars and trucks being $613. The total wholesale value of all motor vehicles was, therefore, $1,380,000,000, or considerably less than the tax collected.

The gasoline tax produced very close to a billion dollars last year; and the total income from taxes placed on automobile owners was 13% of the total tax collections by all federal, state and local governments from every source.

Trailers and the World's Fair

In this issue is an interesting article on the engineering work necessary in connection with the New York World's Fair. In this is described, among many other things, a tremendous parking field. There will also be a trailer parking area capable of accommodating 1,200 trailers, as yet uncompleted. A survey has indicated that between ten thousand and twelve thousand trailers, or 20% of those in the country, will attend the Fair.

Two-thirds of these probably will expect to find accommodations within 90 minutes of the fair ground; one-third expect to be right at the fair. The degree of concentration will depend on how many come at one time and how long the average stay will be. More important is what communities within 90 minutes of the Fair area are going to do about the 8,000 or so trailers that they are going to entertain this coming summer.

Sanitation will be important; that means more water mains and more sewers to serve these areas. Probably of equal or greater importance will be the promulgation of ordinances and regulations governing trailers. If any of these communities do not now have adequate ordinances providing such regulation, they should pass them at once and prepare instructions for the officers who will be charged with enforcing them.

Engineering Briefs:

Traffic Lines Cast in Color

In the paving of the Galveston Island approach to the new causeway connecting with the city of Galveston, Texas, an interesting feature was the novel manner in which the contractor marked the center line, which consists of a 6-in. yellow stripe between two 6-in. black stripes, incorporating the coloring material in the concrete pavement.

The traffic stripe was formed by working magnetic oxide in yellow and black into the finished concrete to a depth of ¼-in. and hand floating to refinish the stripe. The result of this operation is an attractive and straight stripe, with expectations that the two-color scheme will be a valuable guide to traffic.

In order to provide a smooth line for all edges, the contractor developed a hand-propelled machine with an 18-in. hand-wheel and a chain drive to the rear axle. All four wheels of this machine were flanged to keep the apparatus in perfect line on the steel road forms. A three-compartment trough 7-ft. long was built in the cnter of the machine and parallel to the pavement edge. These compartments, composed of structural steel and sheet metal, could be raised by means of a ratchet to permit the operator to move the machine forward. Likewise they could be lowered to the pavement to permit the spreading of the coloring materials and floating them into the surface. The yellow was placed in the center compartment, which is directly over the exact center of the pavement and the black placed in each of the side compartments.—*Highway Research Abstracts.*

The Many Bases for Sewer Rentals

The number of communities that charge sewer rentals is increasing, but there is little uniformity in the bases of the charges. A tabulation of practices of 97 American cities shows that 18 base the rentals upon the number of plumbing fixtures; 8 upon a uniform rate for all customers; 12 upon the number of sewer connections; 19 upon the metered water consumption; 11 upon the type of property; 12 upon the number of fixtures and the type of property; 11 upon a fixed percentage of the water bill; 1 upon the type of property and metered sewage; 1 upon the number of persons; 2 upon the number of plumbing fixtures and the metered water consumption; 1 upon a fixed percentage of the water bill and the type of property; and 1 upon the type of property and the number of persons.

Bridge Testing by Water Loading

A novel bridge test to determine reaction to dead loads has been successfully tried in France. The bridge recently completed over the Loire River comprises a 442-ft. suspension span and two 56-ft. access spans. The type of construction somewhat facilitated the system of testing, the bridge being composed of two longitudinal plate beams, to which cross beams are riveted, the concrete floor resting on the beams.

According to specifications these tests were to be carried out with a dead weight of 400 kg. per sq. m., which would involve the use of 28 16-ton trucks fully loaded, and the distribution of about 100 tons of pig iron. The handling of this iron and the loading of the trucks, as well as the insurance on these trucks, would have involved considerable expense.

To avoid this it was decided to use water for dead weight. The length of the bridge was divided into eight reasonably waterproof sections by erecting 24-in. plank walls across the width of the bridge and covering the walls with a tarpaulin. A pump was used to draw water from the river into the series of tanks on the bridge, the pump being opened into one tank after another. During the beginning of the filling operations the curve of the bridge surface caused a difference in level of nearly 6 in. between one end of the tanks and the other, but as the loading proceeded this curve practically disappeared. Drain holes left in the bridge floor were stopped with wooden stoppers, then opened to release the water into the river.

In carrying out this test there was an interruption in traffic of less than 8 hours. The operation can be carried out for bridges with open railings or girders by merely adding wooden sides to the improvised tanks. It is claimed that this method is much cheaper than ordinary loading, especially for testing long structures requiring considerable dead weight.—*Highway Research Abstracts.*

Aeration Ditch at Amarillo

Amarillo, Tex., sewage is treated by settling, aeration, final settling and sludge digestion. Aeration was formerly effected by compressed air applied through diffusion plates, costing $3500 a year for electricity, and possibly infringing activated sludge patents. For this was substituted a ditch 1400 ft. long, in which are 13 rock dams 18″ high spaced as topography permits, over which the sewage falls, finally falling over a rocky cliff to a creek. This ditch reduces free ammonia from 19 to 4, B.O.D. from 360 to 40, hydrogen sulphide from 10.5 to zero, increases dissolved oxygen from 0 to 3.5. During the growing season practically all of the sewage is used for broad irrigation on alfalfa. The average flow is approximately 2 mgd.

Can a Too-Deep Well Be Refilled?

The question is asked by a water superintendent, whose letter was quoted in our January issue. An answer has been received from Winfred D. Gerber, engineer of the Illinois State Water Survey Division, in which he writes as follows:

It is unfortunate that someone did not understand the subsurface formations, for had this been the case the 600 feet of additional drilling might have been avoided.

Without having the location and the driller's log it is not altogether satisfactory to offer advice, but from the wording of the letter it appears that an open formation exists below the 400-foot depth. This open or porous formation is "drinking" the water from the 400-foot level and unless the downward flow is stopped, other wells in the locality may later be affected.

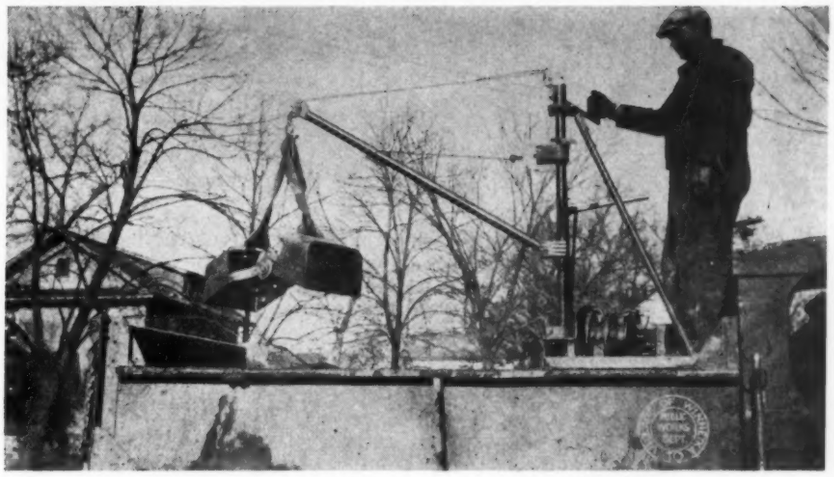
It seems entirely feasible to plug this well below the 400-foot level and to restore the artesian flow. The method for doing this will depend upon the following:

Knowledge of the materials penetrated in drilling. (This is usually called the log of the well.)

Experience and equipment available for doing the job.

The Illinois State Water Survey will be glad to make suggestions for plugging the well if your correspondent cares to send a detailed report.

The address of the Division is Urbana, Ill.



Catch basin cleaner dumping into truck.

Small Clam Shell Bucket Reduces Catch Basin Cleaning Costs

By ROBERT L. ANDERSON
Supt. Public Works, Winnetka, Ill.

A gasoline-operated clam-shell bucket built by the Public Works Dept. of Winnetka, Ill., with a crew of two men, cleans an average of 20 catch basins a day, removing 9 cubic yards of dirt, at a cost of 68 cts. a basin.

IN November, 1938, we put into service a power-driven hoist and clam shell bucket rig for cleaning catch-basins, to replace the former hand method. Results to date have been satisfactory enough to make it of interest to other small cities, where the cost of more elaborate equipment cannot be justified. On the basis of the first six weeks of use we are showing a saving of about 25% over hand methods, and are doing a more satisfactory and sanitary job. As we become more familiar with the equipment and add a few refinements this cost differential may be improved.

The machine consists essentially of a clam bucket handled by a two-drum hoist and derrick built into a steel frame unit which is mounted atop the forward end of the box of a two-ton dump truck. The whole unit may be mounted or dismounted in about fifteen minutes, leaving the truck available for general duty. It was conceived, designed and constructed by the writer and W. H. Davis, garage foreman of the village, at a total cost of $467.96, of which $403.26 was for labor in construction. The cost of the engine, which would be about $40.00, is not included, as we used one from another piece of equipment.

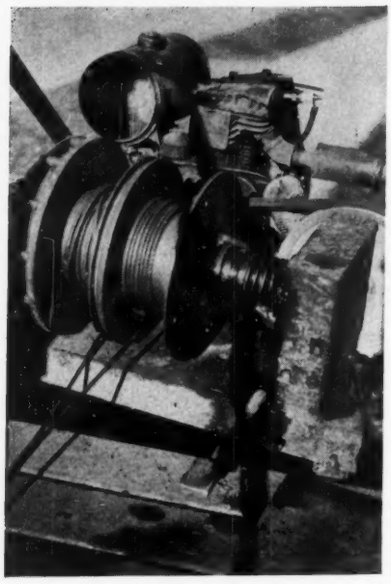
Robt. L. Anderson and W. H. Davis, shop superintendent

The bucket is of one cubic foot capacity to water level, built of 10-gauge steel, with a single arm for each half-shell. Dimensions were figured to permit access through either rectangular or round covers when closed, and full opening inside a three-foot diameter basin. Curved guides are provided at each corner to help in bringing it out of the basin without catching on projections.

The derrick is constructed of two-inch pipe, and is swung horizontally by hand. A hand adjustment for raising the boom is also provided. The two cables are run up through the vertical leg, to take up the twist produced by the horizontal swing.

Power is applied to the winch through a V-belt drive to a shaft carrying a foot-operated clutch and the worm of a worm and pinion set. These operate in oil inside an enclosed gear box, the pinion being mounted on the drum shaft. The drums are driven by normally engaged friction clutches, which may be released by hand controls to lower the bucket. All braking is provided through these clutches and the drum shaft, which is prevented from reversing by a small ratchet attachment inside the gear box. The engine now in use is a 1.2 horsepower Briggs and Stratten, which is operating for a full day on one gallon of gasoline.

In the construction of our drainage system no thought was ever given to the use of machinery in cleaning, and consequently we have found that about 10% of the catch-basins must be cleaned by hand because of structural



Close-up of two-drum hoist, friction clutches and gear box

features preventing the entrance of the bucket. The most usual difficulties are offset covers, pipes running through the basin, and restricted necks, the last of which can be remedied fairly easily.

Our practice has been to clean all basins once a year. We find that we are averaging a little less than one-half yard of material per basin and completing about twenty basins per day, hauling about nine cubic yards of material.

The crew consists of two men—a hoist operator and ground man. The duties of the former are obvious. The ground man removes the cover and guides the bucket into and out of the basin. He is provided with a long-handled spade with which he occasionally pulls the material sticking to the walls to the center for easy loading. This is ordinarily necessary only in dry material. If desired, the bucket will clean up the floor of the basin down to the last shovelful, but ordinarily it is not worth the time to gather up the last cubic foot or so. A number of holes were burnt through the bucket shell to facilitate drainage of wet material.

In our accounting system, equipment rentals are charged against all operations, including all operating and maintenance expenses, but no capital depreciation. Under this arrangement the truck rental is $.25/hr. and the cleaning machine $.10/hr. With a labor scale of $.75/hr. for the operator and $.60/hr. for the helper, this makes a total cost of $1.70 per hour. On a basis of twenty basins and nine cubic yards per day this makes unit costs of $.68/per basin or $1.51 per cubic yard removed.

Refuse Disposal in Two Cities

Lansing, Michigan, is building a new sewage treatment plant at which garbage will be ground and disposed of by digestion with the sewage sludge. Standard garbage receptacles are furnished by the city, and in collection, the can itself is removed, the collector replacing it with a clean can. A garbage handling building provides facilities for unloading the cans, dumping the garbage into hoppers, and sterilizing the cans. Among recently developed features in sewage disposal which are incorporated in the plans for the new Lansing plant are pre-aeration for the removal of grease, a centrifuge to reduce the moisture content of the activated sludge before digestion, sludge incineration, and power production.

The city of Fresno, California, successfully utilizes the sanitary fill method of refuse disposal. The method consists of excavating a trench about three feet deep, filling this trench with refuse, and placing an earth cover about two feet thick over the refuse. The earth cover is borrowed from the next succeeding trench excavation.—*Public Management.*

Chemical Terms and Conversion Factors

A list of the chemicals commonly used in water and sewage, published some time back in the *Clarifier,* South Dakota Water and Sewage Conference, W. W. Towne, state sanitary engineer, is republished here for the use of our readers.

Trade Name	*Scientific Name*	*Chemical Formula*
Alum	Aluminum Sulphate	$Al_2(SO_4)_3 \cdot 18\ H_2O$
Sodium Aluminate	Sodium Aluminate	$Na_2Al_2O_4$
Copperas or Sugar of Iron	Ferrous Sulphate	$FeSO_4 \cdot 7\ H_2O$
Ferric Chloride	Ferric Chloride	$FeCl_3 \cdot 6\ H_2O$
Chlorinated Copperas	Chlorinated Copperas	$Fe_2(SO_4)_3 + FeCl_3$
Ferric Sulphate	Ferric Sulphate	$Fe_2(SO_4)_3$
Blue Vitriol	Copper Sulphate	$CuSO_4 \cdot 5\ H_2O$
Bleaching Powder or Chlorinated Lime	Calcium Hypochlorite	$Ca(OCl)_2$
Liquid Chlorine	Chlorine	Cl_2
Sulphuric Acid	Sulphuric Acid	H_2SO_4
Hydrochloric Acid	Hydrochloric Acid	HCl
Carbon Dioxide	Carbon Dioxide	CO_2
Marsh Gas	Methane	CH_4
Caustic Soda	Sodium Hydroxide	$NaOH$
Baking Soda	Sodium Bicarbonate	$NaHCO_3$
Soda Ash	Sodium Carbonate	Na_2CO_3
Glauber's Salt	Sodium Sulphate	$Na_2SO_4 \cdot 10\ H_2O$
Salt	Sodium Chloride	$NaCl$
Quicklime	Calcium Oxide	CaO
Hydrated or Slaked Lime	Calcium Hydroxide	$Ca(OH)_2$
Calcium Bicarbonate	Calcium Bicarbonate	$Ca(HCO_3)_2$
Limestone	Calcium Carbonate	$CaCO_3$
Gypsum	Calcium Sulphate	$CaSO_4$
Calcium Chloride	Calcium Chloride	$CaCl_2$
Magnesium Hydroxide	Magnesium Hydroxide	$Mg(OH)_2$
Magnesium Bicarbonate	Magnesium Bicarbonate	$Mg(HCO_3)_2$
Magnesite	Magnesium Carbonate	$MgCO_3$
Epsom Salts	Magnesium Sulphate	$MgSO_4 \cdot 7\ H_2O$
Magnesium Chloride	Magnesium Chloride	$MgCl_2$
Iron Oxide	Ferrous Oxide	FeO
Ferrous Bicarbonate	Ferrous Bicarbonate	$Fe(HCO_3)_2$
Ferrous Hydroxide	Ferrous Hydroxide	$Fe(OH)_2$
Iron Rust	Ferric Hydroxide	$Fe(OH)_3$

Abbreviations of Some Water and Sewage Units of Measure

gal.	= gallon
M.G	= million gallons
l	= liter
ml	= milliliter
cm^3 or cc	= cubic centimeter
g	= gram
mg	= milligrams
gr.	= grains
ppm	= parts per million
gr. p. gal	= grains per gallon
cm.	= centimeter

Hard to Remember Factors

1 lb.	= 453.593 grams
1 lb.	= 7000 grains
1 gram	= 1000 milligrams
1 gram	= 15.43 grains
1 meter	= 100 centimeters
1 meter	= 1000 millimeters
1 meter	= 39.37 inches
1 inch	= 2.54 centimeters
1 liter	= 1000 milliliters
1 liter	= 1000 cubic centimeters
1 liter	= 1.056 quarts
1 gallon	= 3.785 liters
1 gallon	= 3785 cubic centimeters
1 part per million	= 8.34 lbs. per million gallons of water
1 grain per gallon	= 17.1 parts per million
1 grain per gallon	= 143 lbs. per million gallons of water
1 milligram per liter	= 1 part per million

Solving Problems of Well Water Supply

Testing Wells for Drawdown

IN TESTING the capacity of wells, both when first drilled and later when it is thought possible that the ground water level has fallen or other conditions of well or surrounding ground have changed, it is necessary to know the drawdown (fall of water level at the well) at different rates of pumping. A simple method of doing this is described by Johnson National Drillers Journal, practicable wherever the well casing is not used as the delivery pipe and where there is at least 1" space between the casing and the pump pipe.

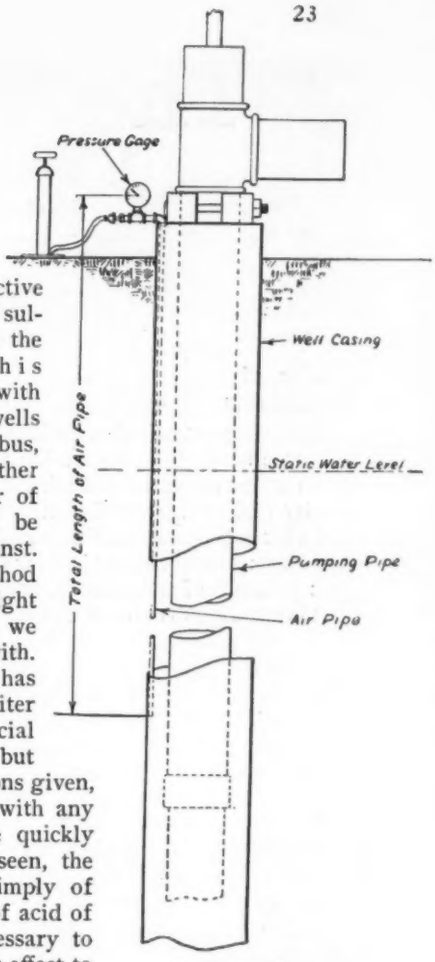
Pass down into the well, between casing and pump pipe, a ⅛" or ¼" brass or iron pipe with air-tight joints which extends below the lowest point to which the water may be expected to fall during pumping, keeping an accurate measure of the length of this pipe. Connect to the top of this a pressure gauge (preferably one marked with feet head) and an air valve, on an extension pipe to which a tire pump can be connected. Figure the exact vertical distance from the center of the pressure gauge to the bottom of the air pipe. Pump air into the air pipe until all the water has been forced out of it (indicated by the gauge standing stationary). The gauge reading then, subtracted from the depth of bottom of air pipe below gauge, will give the distance from gauge center to water level in the well. If the pump has not been operating for some time, this is the groundwater level. When the pump is operating at a rate whose drawdown it is desired to know, repeat the above operation, giving the depth of water in the well. This minus the depth at no pumping gives the drawdown.

The amount of water pumped, in gallons per minute, divided by the drawdown in feet, gives what is known as the "specific capacity," which is commonly assumed to be the same at all pumping rates, but is not always so; in some wells the specific capacity increases with additional drawdown, in some it decreases. By determining drawdown for each of several pumping rates and plotting the results, a curve is obtained from which sufficiently reliable results can be obtained by interpolation.

Reducing Alkalinity of Well Water

Surrounding Columbus, Ga. (and many other towns) are numerous shallow wells used as a water supply by families not served by the city's mains. The State Dept. of Public Health is trying to educate the owners to protect these wells from contamination by casing and covering them. One of the most popular forms of casing is concrete pipe.

Unless such pipe has been aged for 6 to 12 months before use, excess lime leaches out, resulting in excessive total and hydroxide or caustic alkalinity in the well water. A method of overcoming this is described by F. M. Hull, superintendent of filtration of Columbus, in "Drippings from the Georgia Faucet" (Georgia Water and Sewage Association), who states that the same treatment is applicable to new concrete storage basins, pipe lines, etc. His description follows:



Testing wells for drawdown

About the simplest effective remedy is treatment with sulphuric acid, to overcome the excessive alkalinity. This treatment has been used with success on a number of wells in the vicinity of Columbus, and offers no difficulty other than the possible danger of overdosage, which must be carefully guarded against. Believing that the method used for treatment here might be of interest to others, we are presenting it herewith. The accompanying table has been worked out by the writer for the average commercial forms of sulphuric acid, but with the aid of the equations given, the dosage for any well with any strength of acid can be quickly determined. As will be seen, the entire method consists simply of determining the amount of acid of the grades available necessary to give a proper neutralizing effect to the alkalinity present in the water.

1. Titrate sample of the water to determine the total alkalinity, in parts per million.

2. Determine the strength, or H_2SO_4 content of the acid to be used in treatment by its Baume Density or Specific Gravity by a hydrometer and the accompanying table.

3. Determine the number of gallons in the well.

4. From the table given, determine the dosage of acid in cubic centimeters per gallon per part per million total alkalinity.

5. Multiply the sulphuric acid dosage as shown by the table, by the number of gallons of water in the well, then multiply this by the number of parts per million total alkalinity as shown by titration. This result will then give the dosage of acid of the strength to be used, that will completely neutralize all the alkalinity present in the water being treated.

In the interest of safety, only *one half of the calculated dose should be applied on the first treatment.* Make another test for alkalinity after a few days, and repeat the treatment if necessary.

Dosage of Sulphuric Acid in C.C. per Gallon for Each Part-per-Million of Total Alkalinity

Baume	*Sp. Gr.*	*% H SO*	*Dosage*
65	1.8125	88.67	.00235
64	1.7901	85.70	.00246
63	1.7683	83.14	.00257
62	1.7470	81.30	.00266
61	1.7262	79.43	.00276
60	1.7059	77.60	.00284
59	1.6860	75.86	.00296
58	1.6667	74.51	.00304
57	1.6477	72.59	.00316
56	1.6292	71.00	.00327
55	1.6111	69.52	.00337

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

Choice of Coagulants

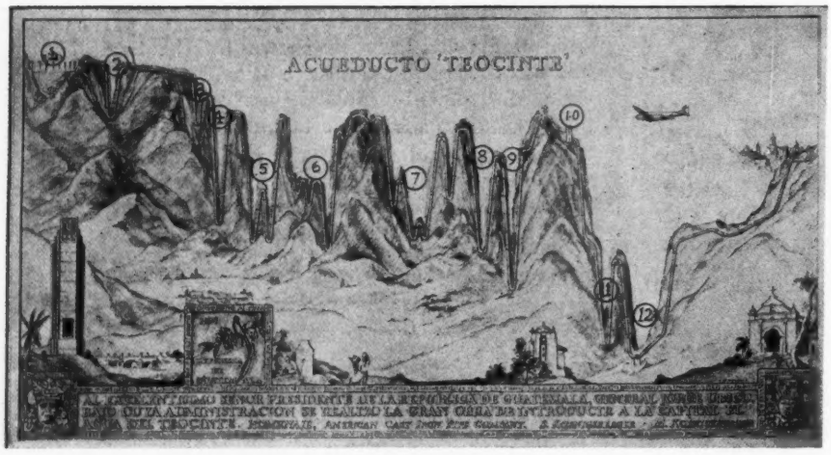
The most economical coagulant to use to secure maximum coagulation with a given water depend upon alkalinity or acidity and pH; mineral content; taste and odor conditions; turbidity and color problems; whether water is clear or turbid; presence of industrial wastes. The first is most important—adapt the coagulant to the water, not the water to the coagulant. There is no need to break down artificially an alkalinity or to build one up unless other factors than coagulation demand it. Many waters contain an abundant supply of coagulating ions, sometimes in sufficient quantities to coagulate the waters if the conditions can be transformed suitably for their reaction. If the water carries little turbidity, a coagulant which includes artificial turbidity is helpful, and the additional presence of activated carbon may be desirable. Coagulants available include aluminum sulfate, iron salts, bentonite, tetanium salts, and sodium aluminate.[A27]

Stabilization with Sodium Hexametaphosphate

The St. Louis County Water Co. has been experimenting with the use of sodium hexametaphosphate for stabilizing lime-softened water, one or two ppm being added either prior to or following filtration. This does not change the pH of the water and acts independently of the alkalinity or pH; it inhibits calcium carbonate incrustation through certain of its surface-active properties. Upon prolonged heating it reverts to the orthophosphate form and loses these properties; at 212° it has some effect, but practically none at 250°. It enables coagulation at the optimum pH and still preventing after-precipitation. It is non-corrosive and can be fed by any solution feeder. The cost of treating with 0.75 ppm at present prices, is approximately that of recarbonation. Possibly other phosphate salts would serve the same purpose; tetrasodium pyrophosphate, with a 0.05 ppm dose, was equally effective at room temperature and acted similarly to hexametaphosphate at higher ones.[G8]

New Aqueduct for Guatemala City

An additional water supply for Guatemala City, Guatemala, has been provided by an aqueduct from the Teocinte river calculated to carry 5 mgd across the several intervening mountain ranges to a filter plant which is 9 miles from the river and 4.5 miles from the distributing reservoir in the city. Pressures on the line vary from zero (where the line passes in tunnel through mountain peaks on hydraulic gradient) to 250 lbs.; and on the distribution system in the city from 50 to 75 lbs. The city is at an average elevation of 5,000 ft. above sea level. The aqueduct is of 18″ and 24″ cast iron pipe furnished by the American Cast Iron Pipe Co. Of the seven tunnels, six average 250 ft. in length but one is 984 ft. Concrete piers and bridges carry the pipe across 12 rivers. The purification plant consists of a sedimentation basin and ten horizontal steel pressure filters of 600,000 gpd each capacity.[Y1]



Artist's conception of profile, Teocinte Aqueduct.

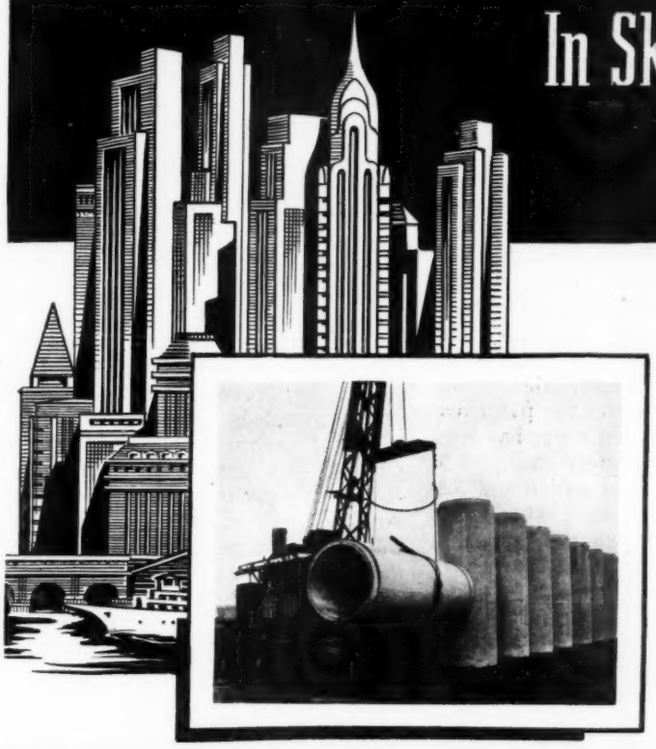
(1) Teocinte River Dam, (2) El Convento dip, (3) Santa Marta dip, (4) Pinula dip, (5) El Tuerto dip, (6) Los Ocates dip, (7) Canalitos dip, (8) Monjitas dip, (9) Acatan dip, (10) Santa Luisa, location of sedimentation basin and pressure filters, (11) Las Vacas dip, (12) La Cienega dip. Guatemala City is indicated at upper right.

Sodium Hexametaphosphate

"Threshold treatment" (adding a very small quantity of sodium hexametaphosphate to water — 2 ppm or even ½ ppm) will stabilize high carbonate hardness waters; demonstrated by plant-scale experience at Delaware and Mt. Sterling, O.; its use just beginning at Columbus, O. When excess lime treatment is not needed to reduce magnesium it may make recarbonation of lime-softened water unnecessary, and even eliminate softening of hard waters where softening is primarily to prevent incrustation. The effect continues even when the water approaches boiling temperature.[G7]

Buying a Turbine Pump

In buying a turbine pump, detailed specifications are desirable. They should state whether the well is in gravel or rock, its diameter and depth; whether plumb or crooked; static water level; corrosiveness of water, if sand will probably be pumped; quantity of water to be pumped; depth of setting (better too deep than too shallow), head to be pumped against; length of suction pipe; to discharge above or below floor level; probable variation of draw-down; non-overloading impeller is desirable; kind and other details of power to be used. An air line for measuring depth of water should be required, with altitude gauge and hand pump. Capacity for which guarantee is required, and efficiency at other rates. In choosing the pump from those offered, consider first the general reputation of the manufacturer; next, the ruggedness of the pump; third, the efficiency; fourth, first cost and operating costs.[A32]



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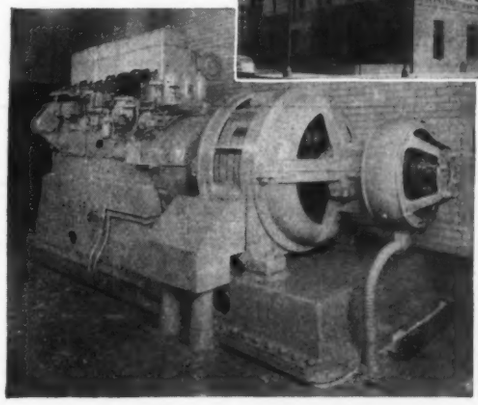

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Cement-Lined Cast Iron Pipe

Corpus Christi, Texas, last year laid 16 miles of 30″ cement-lined cast iron pipe, using portland cement for the joints also. It was assumed that a value of C = 150 could be assumed for such pipe, continuing for many years. A half-inch cement lining was spun on. (Competitive bids for ⅜ in. steel pipe with spun tar enamel exceeded those for cast iron.) Cutting such pipe by cold chisel and hammer was found better than by wheel-type cutter. The latter formed a pressure ridge on the inner surface that broke the lining for some distance back, but cutting with the cold chisel in the usual way seldom chipped the lining back as much as ¾ inch. Cement joints were $29,000 cheaper than lead, and a test joint was not affected by a pressure of 125 lb. per sq. in. If a cement joint was found to leak in the finished line, it was cut out for half the depth of the bell and filled with fresh cement. Original leakage fell appreciably for 2 or 3 weeks; the line leaked at the rate of 33 gal. per in.-mi. per day and later fell below this. Jointing cement was wet just enough to enable it to be balled in the hand, calked half the depth of the bell at a time, calking blows being as heavy as for lead, then covered with a fillet of mud or mortar to prevent drying out. One sack of cement made 5 joints. The trench was dug by a 42″ trenching machine with side cutters, preceded by a small trencher cutting an 8″ pilot trench to locate any pipes ahead.[E8]

Accelator Softening at Georgetown, Texas

Georgetown has installed a softening plant using the "accelator" process, capacity 500 gpm. With one hour detention this reduces alkalinity to methyl orange from 292 to 45 ppm, and alkalinity to phenolphalein from 10 ppm to 0, and raises the pH from 7.0 to 8.9. The original water has free CO_2 content of 29 ppm, using 9.5 grains of quicklime per gallon and 0.5 grain per gallon of alumn. This water is passed through two gravity sand filters at 2 gpm per sq. ft., filters washed once a day. The water first passes through an aerator — slat trays in a steel box 8 x 12 x 7 ft. high, through which air is forced upward at 7,000 cu. ft. per min. This falls into the steel accelator tank, 18 ft. diameter and 15 ft. high, containing two concentric tubes, propellers and agitators. The coagulated lime, or slurry, is mixed continuously with the incoming water, and the excess slurry drawn off continuously to a drain. Construction and operating costs are less than for either lime-soda or zeolite process.[X3]

Deep Well Pump Troubles

A weather proof pump motor, standing idle several months, had absorbed moisture in its coils; when started, the motor shorted out, necessitating an expensive rewind job. Preventive, have motors dry before starting. If lubricating oil runs onto motor windings a short circuit may be caused; do not fill oil cup too full. Lightning may burn out motors; preventive, sufficient properly grounded lightning arrestors. Wear of pump impellers from sand pumped—no remedy, but some types of pumps wear much less than others. At Houston, Tex., maintenance of deep well pumps during ten years equals their first cost, a large part being high cost of raising the pump and replacing in the well.[X7]

Maintenance of Chlorinating Equipment

Give all unpainted metal parts a thick coat of vaseline. Test all connections daily for leaks with strong ammonia. If any connection is broken, even for a short time, close the opening

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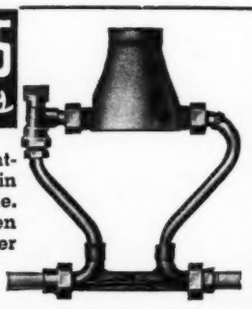

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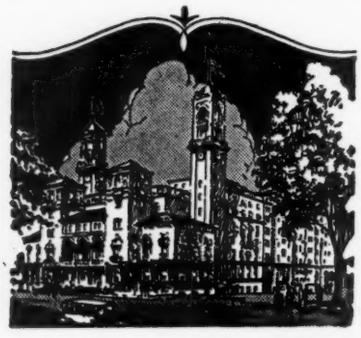

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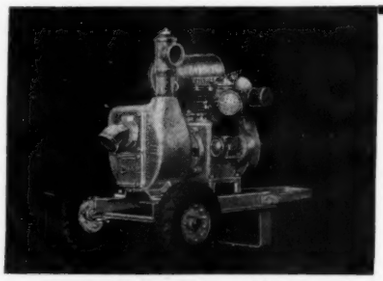

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to exclude moisture. Use only proper tool for removing screws and bolts, which may freeze slightly. Never use water to clean any part except glass. To remove deposits, use wood alcohol or carbon tetrachloride and allow to dry. Use good gaskets at joints to avoid straining fittings. Never force a chlorine valve. Prevent water from getting back into the apparatus. Keep it clean and dry as possible.[X10]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal, American Water Works Ass'n*
January

33. Southwestern Border Water Problems. By J. B. Lippincott. Pp. 1-28.
34. Colorado Aqueduct Distribution System. By J. Hinds. Pp. 29-40.
35. British Grounding Regulations. Pp. 47-50.
36. Graphic Determination of Carbon Dioxide and the Three Forms of Alkalinity. By E. W. Moore. Pp. 51-66.
37. Factors in Coagulation. By B. W. Graham. Pp. 67-73.
38. Quality Throughout the System. By G. E. Harrington. Pp. 74-80.
39. Regulating Water Treatment in Buildings. By J. L. Rice. Pp. 81-86.
40. Automatic Control of Water Works. By C. M. Stanley. Pp. 87-95.
41. Des Moines Iron Problem. By M. K. Tenny. Pp. 96-104.
42. Promoting the Use of Water. By M. K. Socha. Pp. 105-113.
43. Gadgets Become Standard Equipment. By G. C. Sopp. Pp. 114-128.
44. Rate of Flow Register. By F. S. Brainerd. Pp. 129-132.
45. Watershed Yields. By J. D. Carpenter. Pp. 133-136.

B *Journal, New England Water Works Ass'n*
December

1. Double Check-Valve Maintenance and Tests in Connecticut. By F. O. A. Almquist. Pp. 379-391.
2. Water Shed Sanitation. By D. C. Calderwood. Pp. 392-395.
3. Industrial Uses of Water. By W. D. Collins. Pp. 396-402.
4. Water Quality Requirements for New England Industries. By H. J. Skinner. Pp. 403-417.
5. Treatment of Water for Industrial and Boiler Feed Uses. By S. T. Powell. Pp. 418-442.
6. Removal of Iron and Hardness from Water. By D. J. Saunders. Pp. 443-451.
7. Use of Cooling Water in Air Conditioning. By W. H. Sears. Pp. 452-460.
8. Modern Motor Pumpers and Their Influence on Water Works. By G. W. Booth. Pp. 461-465.

D *The Surveyor*
January 20

9. *p.* Some Notes on Water Towers. By E. L. Morgan. Pp. 77-79.

January 27

10. Water Supply in 1938. Pp. 108-113.
11. Welded Joints on Pipelines in Practice. P. 173.

E *Engineering News-Record*
February 16

11. Snyder, Okla., Goes to the Hills for a Surface Water Supply. By F. M. Hieronymus. Pp. 66-67.

F *Water Works Engineering*
February 1

17. South American Water Works, Past and Present. By A. T. Cook. Pp. 126-133.

February 15

18. Necessity of Regulating the Water Well Industry. By R. S. Barper. Pp. 193-194.
19. *p.* Coagulation Economy in Lime-Soda Water Softening. By C. H. Spaulding. Pp. 195-197.
20. Joint Leak Cuts Through Heavy Pipe Wall. Pp. 208, 211.

G *Water Works & Sewerage*
February

8. Stabilization of Lime-Softened Water. By H. O. Hartung. Pp. 56-60.
9. Leak Location in Bristol, Va. By P. A. Goodwyn. Pp. 63-64.
10. Some Experiences in Stopping Leaks. By F. J. Broz. Pp. 75-77.

J *American City*
January

1. Rehabilitation of Water Works After the Hurricane. Pp. 41-43.
2. New Water Supply Main Installed at Corpus Christi. Pp. 46-48.

February

3. Treating a Difficult Water in Athol, Mass. Pp. 71, 73.

K *Proceedings, Am. Soc. of Civil Engineers*
February

1. Laterial Spillway Channels. By T. R. Camp. Pp. 217-228.

P *Public Works*
February

11. Construction of a Model of a Purification Plant. By R. S. Millar. P. 11.
12. Cleaning Mains with Air Bubbles. By R. R. Howard. P. 14.
13. Flow in Pipes Containing Bottom Deposits. By V. W. Willits. Pp. 15-16.
14. Simple Dissolved Oxygen Sampling Device. By F. E. Daniels. P. 20.
15. Warfare Gases and Municipal Sewage and Water Plants. Pp. 21-22.
16. Sanitation Problems for Summer Camps and Hotels. Pp. 22-23.

T *Technique Sanitaire*
December

2. Le Traitement des Eaux de Barrages, de Lacs et d'Etangs. Pp. 230-234.
3. La Deferrisation des Eaux. Pp. 235-239.
4. Le Statut des Eaux Superficielles en Algerie. Pp. 239-240.

Y *Pipe Progress*
February

1. Guatemala City Completes Rio Teocinte Aqueduct. Pp. 1-7, 11.

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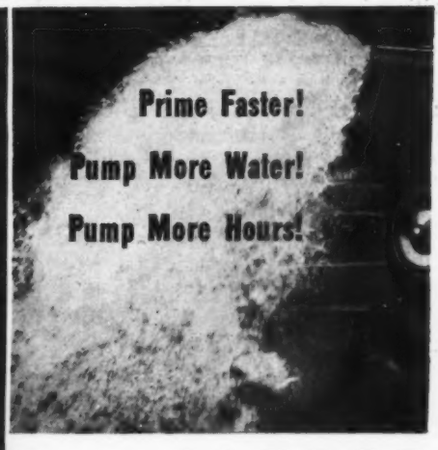

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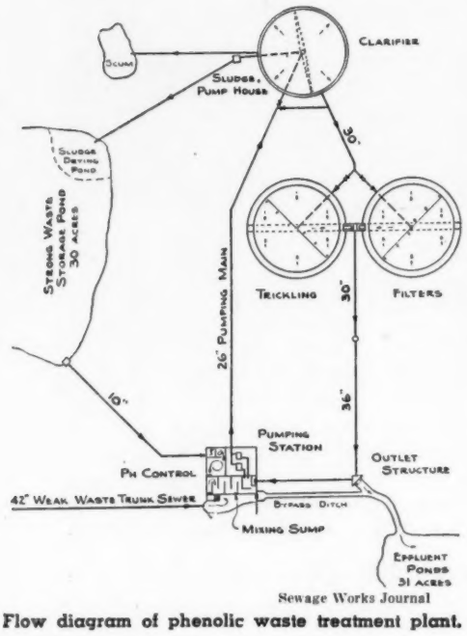
The Sewerage Digest

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

Phenolic Waste Treatment Plant

The Dow Chemical Co., after several years research, has completed a plant for recovering or destroying phenol compounds in its waste waters, which total 20 mgd or more. The principal elements are a settling tank with clarifier mechanism, two trickling filters with power-driven rotary distributors, and 38 acres of ponds that receive the effluent. The plant wastes are classified as weak phenolic and strong. The latter are first stored in a 30-acre pond, and the effluent from this diluted with weak wastes, after having received hydrated lime for pH control. The mixture is pumped to the clarifier, 140 ft. inside diameter, 8 ft. side water depth, designed for 1-hr. detention. The clarifier mechanism removes both sludge and skimmings, the latter being discharged into a swale and the settled sludge pumped into waste ponds. Each trickling filter is 142 ft. diameter and 9.75 ft. deep. Slag was used as the medium, 4″ to 1½″ size, laid with sides sloping 45° instead of retaining walls to save cost. Slag was compared with coke, and several limestones and selected on the basis of durability, size, shape, uniformity, surface contour with relation to bacteria growth and sloughing, ease and cost of handling, and cost of material. Provisions are made to secure the maximum possible ventilation. Filtering at the rate of 2.67 mgd per filter is provided. Power drive was selected because of variation in rate of flow. The lime produces an iron hydrate floc and the clarifier removes much organic matter combined with this. Sludge seldom exceeds 1,000 gpd, and is dewatered by evaporation in a pond. The clarifier removes 8.4% of the B.O.D. but little if any phenol. The phenol reduction by the filter is from 12.2 ppm to 0.41 ppm, 10.3 parts being removed by the top 5.5 ft., 0.6 by the next foot, 0.9 part by the bottom 3.25 ft. Practically all the organic matter in the wastes is in true solution. When well seeded, the filter withstands sudden pH and toxic compound "shocks" with remarkable ability and recovers quickly. They slough continuously and do not pool. There are no filter flies. Last May, when the phenol strength of the applied waste was maximum, 1937 lb. per day of phenol was applied, only 172 appeared in the filter effluent, and 9 lb. in the pond effluent; the filter, operating at 17.9 mgad, removed 5.82 lb. per 1000 cu. ft. per day of phenol and 16.35 lbs. of B.O.D.[C12]



Sewage Works Journal

Flow diagram of phenolic waste treatment plant.

Treating Caustic and Dye Wastes

Industrial wastes, about half caustic and half spent dyes, constitute about 85% of the sewage treated at the plant of Spindale, N. C. They flow into a lagoon of 900,000 gal. capacity (now reduced by sludge to 700,000), the effluent into a 12″ domestic sewer. A 2.5 mg lagoon is planned. This effluent and the domestic sewage flow through a grit chamber; then receives chemicals—110 ppm of copperas, lime when needed and occasionally ferric chloride—thoroughly mixed in a Dorr turbo-mixer followed by a flocculator: sludge from the clarifier being added continuously at the bottom of the turbo-mixer, and supernatant from the sludge decanting tank between mixer and flocculator. The sewage, carrying a heavy floc, highly colored, goes to sedimentation tanks, and from these to two filters, one equipped with 75 mm sand and the other with 8-10-mesh Anthrafilt. The sand clogs much more quickly and is to be changed to Anthrafilt. The filters are washed daily with filter effluent, the wash water being pumped back to the sewage. The filter effluent is discharged, without chlorination, into a creek of about equal flow. Sludge is drawn once a week onto 4 sand and gravel beds. The sewage runs over 300 ppm. alkaline except when the plants are running a sulphur base dye, and the pH is above 10.9 most of the time. The pH of the effluent is about 9.0. The D. O. of stream plus effluent is practically always 5.0 or better.[J1]

Irrigation in Kingsville, Tex.

Kingsville, Tex., has average sewage of 400,000 gpd. which is pumped through a 10″ C.I. pipe to a lake 2.5 miles away, from which it is drawn for irrigation; sewage being withdrawn from the pipe at intervals to irrigate adjacent land. The lake has an area of 12 acres, 21 ft. max. depth, 90 acre-ft. storage capacity. During 1937, 316 acre-ft. of sewage was pumped to the lake; 131 used, 185 lost by evaporation and seepage. Seven in. depth of application is found best, which the sandy loam absorbs quickly; 2 acres in narrow strips are irrigated each day, through master ditches and cross ditches. Sewage is applied at all seasons, that not used at once being still available six months later. It is proposed to irrigate 360 acres along the pipe line with sewage drawn directly from the pipe, and 120 acres from the lake. Rhodes grass and corn are planted.[E4]

Hydrated Lime for Sludge Bulking

To prevent or cure bulking in activated sludge plants, lime has sometimes seemed to be helpful, sometimes not. Some attribute success to pH control, some to killing filamentous growths, some to weighting down floc. The writer, drawing his conclusions from his own experiences at Salinas, Calif., and Grove City, Pa., and those of numerous other operators, believes: (1) That lime is most effective when applied near the aeration tank inlets, the benefits being due to lime plus aeration. (2) Lime can not effect much weighting down of floc, since most of it dissolves or goes into colloidal suspension. (3) Turbidity of effluent caused by lime is due primarily to colloidal suspension of normal calcium carbonate. (4) Effectiveness of lime seems to have no relation to abundance or absence of filamentous growths in the sludge. (5) Sphaerotilus, the most

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common filamentous organism, cannot be destroyed by pH adjustment without impairing biological oxidation. (6) The primary cause of sludge bulking is a lag in biological oxidation of the solids behind the rate of their adsorption, and control of it lies in either speeding up biological activity or providing more time for it to progress before re-introducing the sludge into the sewage. (7) Among the possible causes of lagging are absence of dissolved oxygen, inadequate aeration tank capacity (or short circuiting), presence of too much germicidal waste, or excessive accumulation of CO_2 or other end product of biological metabolism. (8) Lime will neither supply oxygen nor lengthen time for biological oxidation. (9) will not help in case of germicidal wastes unless these are acid. (10) CO_2 is produced in large amounts during the activated sludge process and (11) lime reduces CO_2 and therefore controls bulking when the rate of biological oxidation is limited by the rate of elimination of CO_2. Since the production of this is greatest at the inlet end, that is the logical point to apply the lime. It may be applied at 50 to 300 lb. per mgd in one to four shots during the peak of sewage strength, or continuously to aerator inlets at 300 to 500 ppm until pH at outlet of aerator approaches 8.0, but not longer.[C11]

Hazards at Sewage Plants

These include falls, sometimes caused by oil or grease dropped on stairs or floor; unguarded wheels, pulleys or gears; slipping into sedimentation tanks; infections of cuts, etc.; asphyxiation by sewage gas, chlorine or CO_2, and gas explosions. Preventives: CO alarm and canaries to notify of gas; closed switches, spark-proof motors and tools; gas masks; railings around tanks; cleanliness. Keep first aid kits handy; apply iodine to even the smallest cut in the flesh. At Freeport, L. I., night and Sunday operators call the police department every hour on the hour; if he fails, a motor police officer is immediately sent to the plant.[G6]

Sewerage Status of Texas Municipalities

At the beginning of 1938, 436 Texas municipalities had sewerage systems, of which 363 were municipally owned, 62 privately owned, 6 owned by the Federal government, 3 by counties and 1 by the State. Of these, 349 treated their sewage, 11 of the untreated being municipal and 3 private. These treatment plants used one or more of the following kinds of treatment: Imhoff tanks, used by 294 plants; septic tanks by 94; sedimentation or settling by 48; screening by 1; activated sludge or aeration by 19; chemical precipitation by 2; contact filters by 6; Dunbar filters by 40; trickling filters by 108; irrigation by 74; separate sludge digestion by 21; lagooning by 7; liquid chlorination by 44; hypochlorination by 44; odor control by 12.[X7]

Pumping Sludge Into Sewer

Pensacola, Fla., has built two treatment plants, one to serve 12,000 population, the other 8,000. Both pass the sewage through automatic screens and settling basins and thence to the bay. The sludge and screenings from the smaller clarifier are pumped by a Shone ejector through 3,000 ft. of 4" cast iron force main to a main sewer through which it flows 3,000 ft. to the larger plant, where the sludge of both plants is digested in a Dorr mult-digestion system, theoretically remaining in the primary digester for 4 weeks and in the secondary for 8 weeks, thence to sand drying beds. The digesters are heated by gas-heated water, a temperature control being used to permit mixing cool water with hot from the boiler, using a thermostatic bulb and 3-way control

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valve to automatically deliver water to the digester coils at 100° to 130°. Operator clocks operate clarifier and comminutor and sludge pumps on a time schedule.[J3]

Filter Bed Materials

Media for filter beds—granite, porphyry, clinker, slag and metallurgical coke—are compared on the basis of (1) durability, (2) low conductivity, (3) high surface area-volume ratio, (4) rough texture for film adhesion, (5) high percent of voids, (6) low specific gravity, (7) no tendency to pack in use, and (8) cost per cu. yd. Granite is graded as (1) very good, (2) not very satisfactory, (3) and (4) good, (5) 40%, (6) 1 cu. yd. per ton, (7) slight, encouraging ponding. Porphyry—(1) best, (2) not very satisfactory, (3) good, (4) fair, (5) 37%, (6) 1 cu. yd. per ton, (7) same as granite. Clinker—(1) unreliable, (2) fair, (3) best, (4), (5) and (6) variable, (7) appreciable. Slag—(1) free lime may slake, (2) and (4) fair, (3) very good, (5) 45%, (6) variable, (7) appreciable. Metallurgical coke—(1) satisfactory over 20 yrs., (2), (4) and (7) best, (3) good, (5) 48%, (6) 2¼ cu. yd. per ton, (7) 50% to 100% more than others.[D10]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

D *The Surveyor*

January 27

9. Sewerage in 1938. Pp. 113-121.

February 10

10. *p.* Economic Design and Efficiency of Sewage Disposal Schemes. by L. J. Ball. Pp. 257-258.

February 17

11. *p.* The Role of Macro-Organisms in Bacteria Beds. By T. B. Reynoldson, Pp. 279-281.
12. *p.* The Respiration of Activated Sludge. By N. W. Barritt. Pp. 281-282.
13. *p.* Double Filtration. By N. W. Barritt. P. 282.
14. *p.* The Work of Chemists and Bacteriologists in Sewage Purification and Disposal. Pp. 283-284.

E *Engineering News-Record*

February 16

8. A Two-in-One Disposal Plant. (Herkimer, N. Y.) By H. W. Taylor. Pp. 71-73.

G *Water Works and Sewerage*

February

8. Progress in Sewerage and Sewage Treatment. By L. V. Carpenter. Pp. 45-55.
9. Rehabilitation of Old Brick Sewer. By H. A. Nelson. Pp. 78-80.

H *Municipal Sanitation*

February

15. World's Fair Speeds Tallman's Island Sewage Works. By R. H. Gould and H. Liebman. Pp. 92-93.
16. Golden Gate Exposition Plant Will Comminute and Dilute Sewage. By C. H. Lee. Pp. 94-96.
17. Copperas Production at El Paso Saves $3,000 Yearly. By C. D. Yaffe. Pp. 99-101.
18. Sewage Works Maintenance—Sludge Handling and Conditioning. By L. M. Johnson. Pp. 102-105.

J *American City*

January

1. Complex Treatment for City Sewage, Caustics and Dies. P. 51.
2. Hand Winches Lower Sewer Lines for Force Main. Pp. 67, 69.

February

3. Two New Sewage Treatment Plants at Pensacola. Pp. 51-52.

K *Proceedings, Am. Soc. of Civil Engineers*

February

1. Malaria Control for Engineers, Committee Report. Pp. 229-274.

P *Public Works*

February

9. Constructing Sewers for a Town of 1,500. By R. M. Lingo. Pp. 12-13.
10. *n.* Catchbasin Connections in Deep Sewers. P. 18.
11. Simple Dissolved Oxygen Sampling Device. By F. E. Daniels. P. 20.
12. Warfare Gases and Municipal Sewage and Water Plants. Pp. 21-22.
13. Sanitation Problems for Summer Camps and Hotels. Pp. 22-23.

Disputed Bill for Construction Work

The New Hampshire Supreme Court holds (C. & R. Constr. Co. v. City of Manchester, 1 Atl. 922) that where there was a dispute between a city and a construction company as to the amount the city owed the company and the city sent the company a check with a letter stating that the check was in final payment under the company's contract to construct a reservoir for the city, and the company had the check certified but did not notify the city that it did not accept the check on terms of full settlement, the company was estopped to deny that it accepted the check in full settlement.

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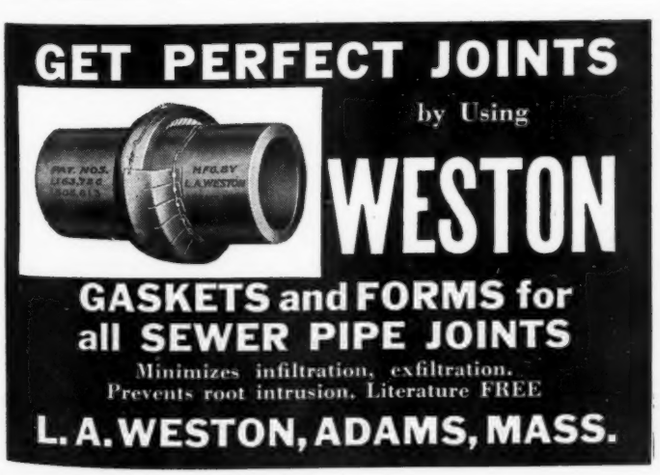

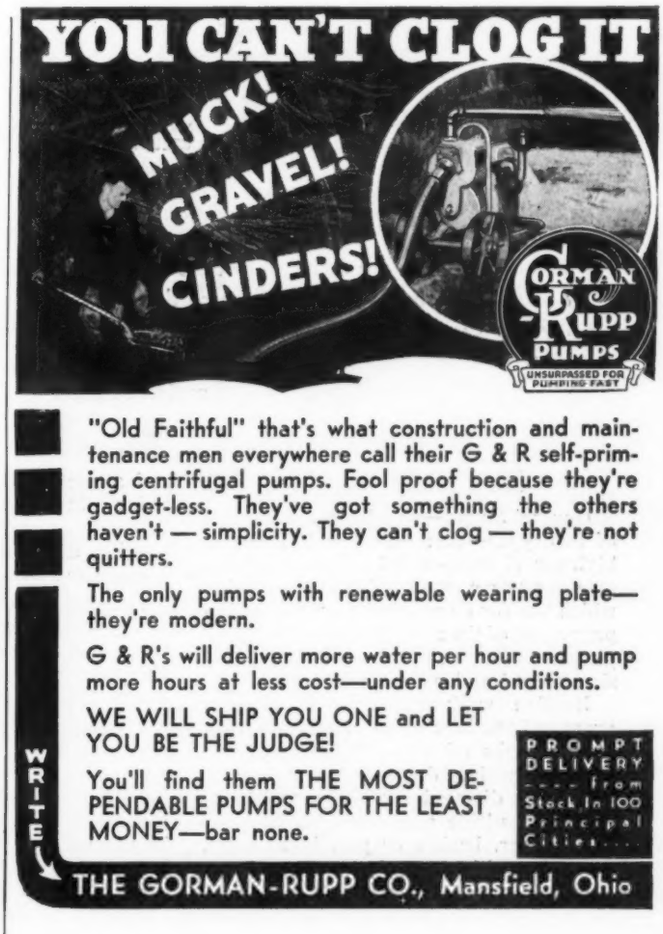
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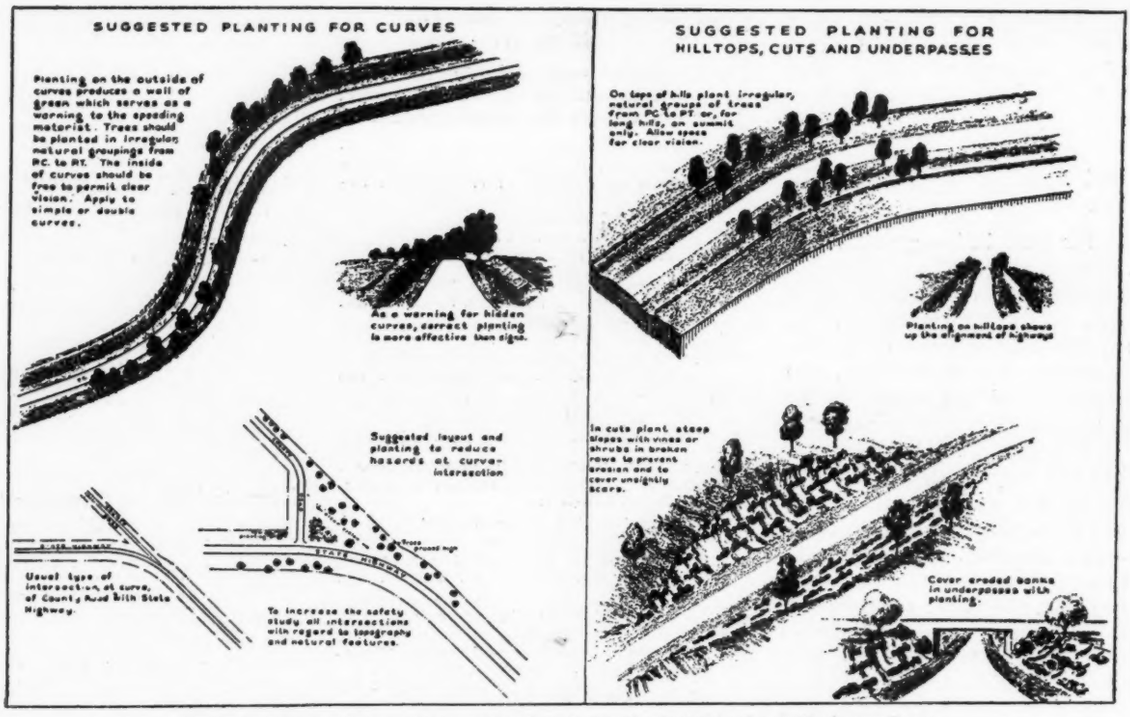
SUGGESTED PLANTING FOR CURVES
Planting on the outside of curves produces a wall of green which serves as a warning to the speeding motorist. Trees should be planted in irregular natural groupings from PC. to PT. The inside of curves should be free to permit clear vision. Apply to simple or double curves.
As a warning for hidden curves, correct planting is more effective than signs.
Suggested layout and planting to reduce hazards at curve-intersection
Usual type of intersection of curve, of County Road with State Highway.
To increase the safety study all intersections with regard to topography and natural features.
SUGGESTED PLANTING FOR HILLTOPS, CUTS AND UNDERPASSES
On tops of hills plant irregular, natural groups of trees from PC to PT or, for long hills, on summit only. Allow space for clear vision.
Planting on hilltops shows up the alignment of highways
In cuts plant steep slopes with vines or shrubs in broken rows to prevent erosion and to cover unsightly scars.
Cover eroded banks in underpasses with planting.

Suggested Roadside Improvement Designs by Jac L. Gubbels, Texas Highway Dept.

How to Maintain Highways and Streets

Prepared by

W. A. Hardenbergh and Consulting Staff

This is the third of a series of articles covering maintenance of highways and streets. Tentative scheduling of the remaining articles is as follows: APRIL: Gravel road maintenance. MAY: Maintenance of bituminous, brick, concrete and other surfaces. JULY: Soils in highway maintenance. AUGUST: Equipment and materials used in maintenance.

Roadside Work

General Scope.—Work on roadsides is of two types—that necessary to keep the highway right-of-way in good condition, safe for travel, neat and clean; and that which has for its primary purpose the improvement of the roadside areas, including planting of trees, shrubs and grass, erosion control and other similar work.

Routine work will include mowing grass and weeds; cutting brush; removing broken limbs of trees, fallen trees and stumps; cutting down dangerous trees; destroying diseased shrubbery, and keeping the roadside area clean of waste or other paper, broken or prohibited signs, and other objectionable materials. Also, in order to maintain roadsides in clean and attractive condition, it is economical to keep them smooth and in such condition that grass and weeds can be cut with a mowing machine.

Roadside improvement work falling to the maintenance organization includes grass, shrub and tree planting and care; filling of borrow pits; rounding and smoothing of cuts; and erosion control and prevention.

Mowing and Burning.—No fixed time can be set for mowing or cutting of weeds and grass. The best time depends upon the locality and on the rainfall, temperature and other factors. Weeds should never be allowed to go to seed; grass should not be permitted to get so long as to be unsightly. A final mowing should be given before the first frost. Mowing and cutting should cover the entire right-of-way.

If the grass has a good and uniform growth over the entire right-of-way, many varieties of weeds will be eliminated; it also has another advantage, in that mowing about twice a season will be sufficient whereas a stand that is uneven and weedy will require more frequent mowing to maintain good appearance. In mowing or cutting, care must be taken not to injure desirable trees, shrubs and vegetation.

Burning requires careful management. Fires should be started on such days and on such side of the road as not to carry smoke across the traveled portion of the highway; fires should not be started near guard rails, timber bridges, poles, trees or other places where it may cause damage; nor near standing crops that may take fire; nor in such a manner that the blaze may spread off the right-of-way; nor where the fire may destroy sod. It may be necessary to remove weeds from the right-of-way for burning, though sometimes, under favorable conditions, they may be burned in place with a torch or burner. Also, since weeds cut in flower are apt to go to seed, burning of the weeds in place, or burning over the ground will reduce seeding. Do not burn the entire right-of-way, as it destroys shelters for,

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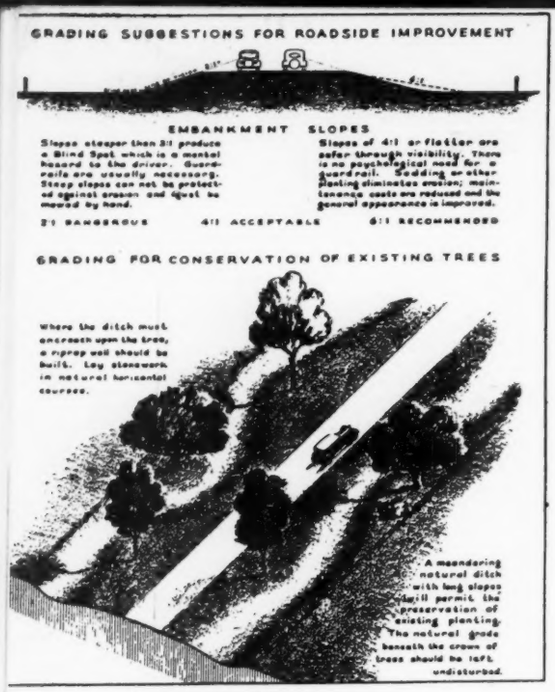

GRADING SUGGESTIONS FOR ROADSIDE IMPROVEMENT
EMBANKMENT SLOPES
Slopes steeper than 3:1 produce a Blind Spot which is a menace to the driver. Guard-rails are usually necessary. Steep slopes can not be protected against erosion and must be mowed by hand.
Slopes of 4:1 or flatter are safer through visibility. There is no psychological need for a guard-rail. Sodding or other planting eliminates erosion; maintenance costs are reduced and the general appearance is improved.
3:1 DANGEROUS
4:1 ACCEPTABLE
6:1 RECOMMENDED
GRADING FOR CONSERVATION OF EXISTING TREES
Where the ditch must encroach upon the tree, a riprap wall should be built. Lay stonework in natural horizontal courses.
A meandering natural ditch with long slopes will permit the preservation of existing planting. The natural grade beneath the crown of trees should be left undisturbed.

More suggestions from Texas

and small game and birds; also desirable trees and shrubs.

Spraying with chemicals is often employed to kill weeds. Sodium chlorate is highly inflammable; Atlacide and Weed Cop are much safer to use. There are also special trade compounds. Most state highway departsments have adopted standards for spraying weeds and in most cases, chemical sprays should not be used without authorization of the engineer.

Sight Clearing.—At those points where the sight distance can be materially increased and the traffic hazard decreased by clearing away timber growths on adjacent property, an effort should be made to obtain permission from the property owner to do this. In such work, all scrub or small growth should be cleared to the surface of the ground. Trees having a diameter greater than about 5 ins., and where possible even smaller ones, should be trimmed in an effort to obtain the required sight distance, rather than be removed. The slashings from such work should be piled and burned.

Removal of Debris, Dead Animals, etc.—The maintenance forces should remove promptly, from the traveled way or from the shoulder areas, trees or branches that may fall or be blown down; and should remove debris and waste materials. Timber, logs or other materials that have been dropped on the highway should be removed, or the owner located and notified, the material, of course, being so placed that it is not a hazard to traffic in the meantime. The state or county police or other law enforcement agencies should be notified at once regarding abandoned automobiles, the maintenance forces taking a receipt and noting the make, model, and engine number of the car.

Dead animals afford varying problems, depending upon local laws. In general, the maintenance foreman or supervisor should determine the ownership, if possible; note the possible liability of the highway department; and in case of doubt or delay in fixing ownership or responsibility for burial, should bury the animal within the right-of-way limits. If this is not possible, permission for burial on private property must be obtained.

Construction materials remaining after maintenance operations should not be left along the roadsides, nor thrown on abutting property, but picked up and hauled to suitable designated dumping grounds.

Roadside Improvement

Aside from covering the scars of construction and carrying out a planned program for increasing the attractiveness of our highways to the traveling public, roadside improvement has, as its chief aims, reduction in maintenance costs through prevention of cut and fill slope erosion, and increasing the safety of the highway.

Roadside work, when considered on a broad scale, includes the following: Conservation and care of existing trees (pruning, spraying, fertilizing, etc.); the selective cutting or thinning of existing growth, the removal of stumps, dead material, loose stones, and such other debris as will interfere with maintenance operations; the obliteration of borrow pits, traces of old roads and other construction scars; the widening of shoulders and the elimination of hazardous side ditches, the flattening of slopes and the rounding of slope intersections; the smoothing out of rough places on the right-of-way that would interfere with mowing or other maintenance operations; the top-soiling, soil improvement and seeding or sodding of shoulders or slopes; the advance preparation of planting areas and the appropriate planting of raw slopes, incidental structures (as bridges) and intersections; special constructions, as scenic overlooks, picnic areas, parking places and similar features; and the regulation of utility companies and the proper location of their structures.

"In a broad sense," said Guirey, "such work on highways should be done with a view to returning to a natural condition, the land adjacent to the highway, where much of the original beauty has been marred or destroyed by construction." And he asks: "How does your right-of-way look? Is it devoid of vegetation? Does your road boast of a string of borrow pits? Have your cuts been hacked through the soil and left to erode? Are your fill slopes of such steepness that the erring motorist who inadvertently runs over them, has an excellent chance of waking up with a harp (or shovel) in his hands? Have your culverts been so designed that they have caused concentration of the runoff with resultant scouring and gouging?"

A primary purpose of roadside improvement, of course, is to conserve and develop the natural growth along the highway borders. This and other work of this character should follow a well thought out plan though hard and fast rules are neither necessary nor desirable.

Most state highway departments have personnel trained in this work, from whom advice and assistance can be obtained. The first requisite is a survey of what is available. This can be followed by the formulation of a general plan, and the application of details of it to local problems.

Trees and Shrubs.—The first thing to do is to take stock of what you have and to study what can be done to conserve it. There are often fine trees that have dead wood in them, or broken branches, an unsightly form, or other imperfections. There may be native shrubs that need only relief from the choking of surrounding weeds or brush; young trees that are badly crowded may need thinning. But do not destroy anything until it is absolutely certain that it is worthless.

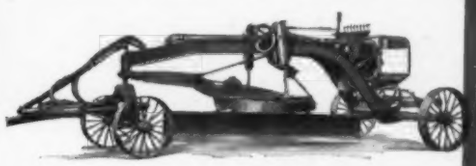
Where a highway passes through a wooded area, local widening of the right-of-way to provide a sufficient border of existing growth may be utilized to give the effect of bringing the woods out to the highway rather than cutting them off at the fence line. Frequently, in other areas where there are only a few trees along the edge of the road, a slight change in the grading of a slope, or in the location of a side ditch, or even the occasional use of a tree well and underdrains, will save a particularly fine tree or a clump of trees.

The planting of trees at regular intervals along the road without regard to their environment, is not satisfactory. Proper arrangement of the trees and their selection with due regard to soil and other landscape factors is important.

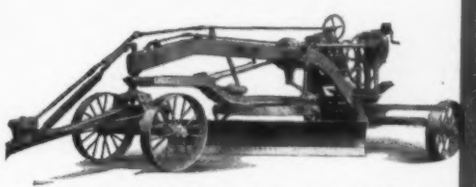
On the outside of a curve, trees make an effective guide to show the alinement of the highway. On the inside of a curve,

A flume protects fill slopes against erosion

Galion No. 70 leaning wheel grader with manual control and pneumatic tires.



Galion No. 120 pull grader with hydraulic control. Standard blade—12 ft.



Galion No. 210 pull grader, an entirely new grader in the 10-foot class with manual control.

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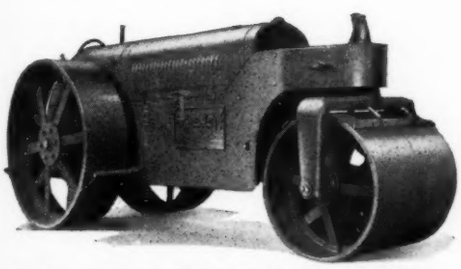
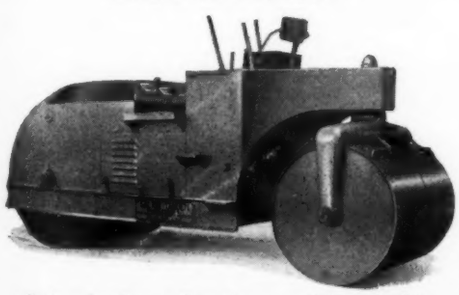
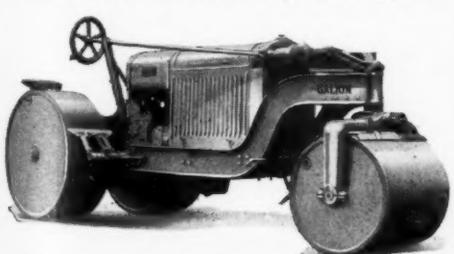


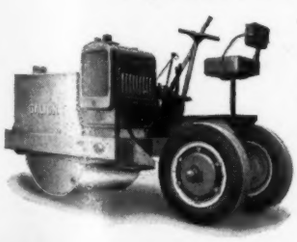
Galion 3-wheel rollers in 6 to 14 ton sizes. Diesel or gasoline engine. Large view above shows two Galicn Master diesel motor graders doing a real blading job.



Galion tandem rollers have weight variable from 5 to 14 tons. Diesel or gasoline engine.



Galion International rollers also have variable weight from 4 to 5 tons.



Galion portable rollers are used for patch work, rolling drives, lawns, etc. View at right shows a Galion No. 110 pull grader maintaining dirt roads.

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Tractor and grader cleaning ditch (Courtesy Cletrac)

they may interfere with desirable vision and should be kept thinned and trimmed to afford necessary sight distance.

This text will not attempt to go into the details of the planting of trees or shrubs. Local conditions vary greatly and it is necessary that advice for procedure be based on a knowledge of local conditions. Most of the state highway departments have a landscaping division from which helpful service can be obtained, and often actual aid in planning or launching a program. Some very good booklets are available from the Bureau of Public Roads or the Department of Agriculture, and from several of the state highway departments. Local nurserymen are often willing to contribute sound advice. The men in charge of local maintenance should seek such sources of information, and while in the process of obtaining adequate data on which to plan work of this type, should study their problems and conserve what is already there.

Local trees and shrubs are always best for planting because they are ultimately cheaper and the loss is less, and because following nature is one of the safest procedures. Nursery grown stock may be desirable. Flowering, fruit or nut trees, are questionable, for passersby are apt to damage or destroy them.

Straight line planting at regular intervals looks artificial; moreover, the vacant spaces that result from tree losses, are especially noticeable; more trees are required than for informal plantings. The illustrations herewith from Texas, show some excellent groupings.

An important phase of this work is cooperation with public utilities in regard to pole lines and structures, and to maintenance work in connection with such lines.

Removal of Stumps and Stones.—Stumps, rocks, loose stones, and rough ground interfere materially with the job of maintaining the roadside in good condition. Stumps may be removed by pulling them out with a tractor or truck, if not too large; or by blowing them out with dynamite, using care not to damage adjacent property or endanger travelers. The hole should be filled with a good grade of earth and smoothed over. Rocks can be removed by prying, nosing out with a bulldozer or blasting. If the roadside slope is not too steep, it can be leveled and smoothed with a tractor and bulldozer or a motor maintainer or blade grader. In this connection, note the information to follow on the desirable slope of cuts and fills to prevent erosion.

Stump and stone removal is necessary but once, and the resulting economy in mowing the roadside will ordinarily repay this expenditure in a short period of time. Hand mowing is relatively costly as compared to machine mowing and does not produce as smooth and neat a result.

Borrow Pits.—In many sections, borrow pits are common, material having been taken from them to elevate the roadbed, or for making fills. However desirable the purpose that was served in making them, they are objectionable for a number of reasons. They tend to hold water, producing mosquitoes and detracting greatly from the appearance of the roadside; they may furnish capillary water to weaken the subgrade under the road; and they are nearly always a hazard to automobiles leaving the road.

Eradication is none too easy; they may be filled up with excavated material obtained in widening or back-sloping a cut; or they may often be eliminated by blending them into the remainder of the roadside. This can often be done on a road that is maintained with a motor maintainer or grader with only slight interference with maintenance work. When working on the shoulders, the deeper portions of the borrow pit may be filled with material taken from the back and from both ends. With well-planned work, it will not take many passes of the grader to smooth and slope the area so that it will not be objectionable. Drainage also helps.

Once borrow pits have been drained out, smoothed and filled in by these means, they should be left alone except for the necessary slight work on them in connection with ditch or shoulder maintenance. Usually they will re-seed themselves; otherwise grass seed should be sown. If the material is of such nature that grass will not grow, a little top-soil may be brought in as a base.

Sometimes the waste material from working shoulders and cleaning ditches can be used for filling.

Widening Shoulders.—The subject of shoulders has already been discussed, and their desirable width from a strictly useful viewpoint has been given. From the viewpoint of roadside improvement, liberal shoulder widths are desirable; about 8 feet to the break of the ditch is recommended. This is not always economically possible on other than highly improved roads, where such a width permits temporary parking off the pavement and also provides space for public utility lines and other adjuncts to highly developed highways.

Cuts and Fills.—On cuts, the usual 1:1 slope is difficult to maintain on most soils, and a flatter slope is desirable. In deep cuts, the attainment of 2:1 slopes may be costly. In such cases, the top of the slope should be rounded off and the face planted with vines or shrubs in broken rows, as shown in the accompanying illustration. Or, in extreme cases, the planting and staking methods shown hereafter in connection with erosion prevention may be used. It is most desirable that the top of the slope be rounded off. Grass will not grow down over the usual sharp break where the slope of the cut intersects the natural ground surface, and more or less serious erosion, depending on the type of soil and topographical conditions, takes place.

On embankments, it is desirable that a 3:1 slope be used, or even a flatter slope. With a 2:1 slope, there is a blind spot which produces a mental hazard on the motorist, while slopes of 3:1 or flatter, remain in full view. Erosion can be elimi-

Slope protected against erosion by planting of shrubs

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Left, a ditch lined with asphalt to prevent slope wash; right, asphalt treated shoulder levee to prevent erosion.

nated by means of planting or sodding. The accompanying illustration shows a typical condition.

Flattening out of fills requires additional material and increased cost, due to procuring and hauling this. If cut slopes are reduced, material is available for improving the fills. On cuts up to about 6 feet, a tractor drawn blade grader is excellent. On smaller cuts, a motor patrol can be used, or a bulldozer or scraper. With these, the bank is cut back to the desired slope and the top rounded off to meet the natural ground surface. Where the fill is in close proximity to the cut, as is often the case, the earth from the cut can be carried out to the fill and used to widen out the base. If this is not possible, the material often can be placed in the ditch, since on through cuts the material for shoulder maintenance is usually taken from the ditches, with the result that these are deeper and wider than drainage will ever require and consequently present a hazard to road-users.

A heavy brush drag is a good tool for final finishing of cut or fill slopes, though it wears out quickly. It is much cheaper than hand work and has the advantage, compared with blade graders or bulldozers, that it does not tear out stones, snags, roots and other embedded objects. It will not produce the often desired "sandpapered" finish, but will give one that is sufficiently smooth and much more practical. It can be hauled behind a truck or tractor. S. E. Fitch recommends a drag of wire mesh, such as is used for reinforcing culverts, which he states to be as good and more durable.

Seeding and Soil Preparation.—The work of adding top-soil, seeding, sodding, and the advance preparation of the soil for planting is largely a local problem and is influenced by types of soil, and many other factors which cannot be satisfactorily discussed here.

Roadside Areas.—The development of picnic areas, small parks and parking places for resting, lunching or making minor adjustments to cars, is an essential part of roadside development. The recognition of opportunities for such developments, is an obligation of the engineer, supervisor, or foreman. In many cases, only a little work with a grader is needed. In general, no set rules or information can be given regarding the development of such areas, but experience has shown that such areas should be provided at intervals of not more than one mile. A study of local conditions will quickly indicate areas that are suited for such development.

Co-operation.—In roadside development work, it is important to obtain the co-operation of operators of service stations and roadside stands; cities, and even smaller communities; and residents. Service station operators and proprietors of roadside stands and stores may be asked o clean up their grounds and provide planting. Usually it will be necessary to be prepared to advise them on what they should do. Therefore, in this, as in all other phases of roadside improvement, advance thought and planning are necessary. Also, property owners may be asked for permission to flatten back-slopes, which in many cases improves both private property and right-of-way.

As stated before, a consideration of what the existing conditions are, coupled with a study of the texts that are obtainable from your state highway department, and advice by the engineer in charge of such work in your state, will furnish a sound basis for procedure.

Controlling Erosion Along Highways

This work falls under two headings: 1. Preventive measures that are applied in the construction of new roads and rebuilding of old ones; and, 2. Control measures for existing roads. For the most part, the duties of the maintenance organization will be confined to the second.

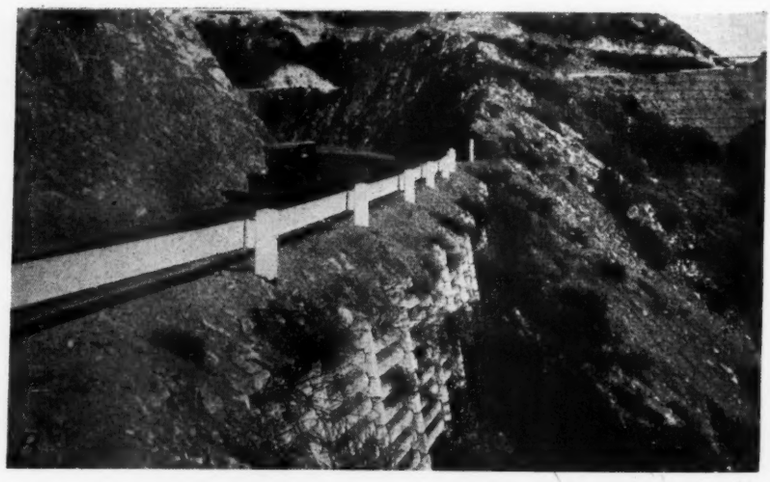
"No sooner is a road constructed," says Charles J. Kraebel in Bulletin 380 of the U. S. Department of Agriculture, "than the forces of nature are at work to destroy it. Water and wind, cold and heat, and the constant pull of gravity combine to break up the road surface, tear down the fills, and round off the squared edges of shoulder berms and backslopes. . . . On newly improved roads, the wear by traffic is unimportant compared with these natural forces; and of these forces, the most powerful by far is water."

In construction, erosion can be controlled and greatly reduced by a more liberal use of walls and cribbing to reduce the volume of both cuts and fills; and these, combined with a moderate amount of hauling to place excess material in places where it will not cause damage by washing or sliding, will greatly reduce after maintenance, unsightly scars and damage to vegetation.

Methods of Control on Existing Roads.—The measures for correcting conditions causing or tending to cause erosion fall into two broad classifications—improved and more effective drainage, and stabilization of slopes by means of vegetation.

Adequate drainage is really the first step in erosion control, both as a preventive measure on roads being built, and also as a maintenance procedure. Even where slope stabilization by means of vegetation is employed, proper drainage is also a requisite.

Drainage Measures.—Fill slopes are eroded from several causes. Pipe culverts



Small crib wall reduces the cut and also the erosion tendency

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are emptied at the top, in the middle, or at one edge of a fill, with resultant cutting out of gullies in the fill. Water may follow down along the road, as from a cut, and overflow the shoulders, also cutting out gullies. A high shoulder may back up water on the road surface and concentrate the overflow at one point, again resulting in erosion. Inadequate culverts at low points of inside curves on fills may result in backing up of the water, overflow of the road, and washing out of the fill on the other slope.

It should also be noted that almost as destructive results occur if the overflow water from any of the above conditions is concentrated on brush covered slopes. Even sodded areas will be destroyed if the volume and velocity of the water are considerable.

In regard to culverts, every effort should be made to discharge the water from them beyond the toe of the slope. Where the culvert empties part way up the fill, a pipe or flume will be needed to carry the water down the slopes, where it should be emptied in the final channel. Metal culverts or half culverts, or flumes are suitable for this. The final discharge, if not in the natural drainage channel, should be on rock talus or other material firm enough to resist erosion.

Treatment of Fill Slopes.—If the road is properly drained, the fill slopes will require protection only against wind, gravity and the rain that falls directly on them. Stated most simply, this protection comprises four steps: (1) Preparing the slope by smoothing existing gullies and combing down loose rock; (2) mechanical anchorage of the slope surface by contour trenching, wattling and staking as best suited to local soil conditions; (3) the sowing of cereal grains or other quick-growing annuals to gain the rapid soil binding benefits of the fibrous roots of this temporary vegetation; and (4) the planting of suitable vines, trees and shrubs to establish a complete self-perpetuating cover of vegetation on the slope. The use of retaining walls, discussed later in this text, should always be considered. Mississippi has been experimenting with protection by staking light cotton cloth entirely over the slope, and allowing the grass to grow through the cloth.

The smoothing of the slopes can be done by suitable equipment or with hand tools depending on the size of the job and conditions of work. On badly eroded slopes, it will not be possible to eliminate the large and deep gullies, but these should be rounded off to as flat a curvature as possible.

The steps in anchoring the soil by contour trenching, imbedded wattling, staking and sowing of cereal grains are shown essentially in the accompanying illustrations, and the process is described in detail in Circular 380, Department of Agriculture. This circular can be purchased from the Superintendent of Documents for 10 cents.

The soil in fill slopes, although largely subsoil and therefore supposedly sterile, is usually found to produce excellent growth because of the thorough mixing and aeration to which it is subjected in the road-building process. Sodding reduces maintenance and may cost less than seeding.

Maintenance and Repair.—Constant inspection and maintenance of erosion control work is especially important during the first rainy season after completion. Careful provision for this first-season maintenance should be made.

Intelligent maintenance starts with a knowledge of what to look for. Breakdowns are of two general types: (1) Gullies and side-cutting resulting from spillovers of road surface water at points where sufficient drainage has not been provided or where drainage structures have become clogged; (2) failure of the slope treatment by sloughing or slumps.

Since slope treatment is designed to control only the natural rainfall on the slopes and not concentrated drainage water, correction of defects in drainage is the first step. Gullies should be repaired by scarifying transversely or trenching the bottoms, filling, compacting, staking heavily and rewattling. Stakes should reach into the compact original bottom; and even double staking may be desirable. The bond between the gully bottom and the new fill material should be made as good as possible.

Slumps are most liable to occur on slopes containing a large proportion of clay. Repairs should follow essentially the same general practice as in gully repairs, but even greater care should be taken to establish the bond between the slump-ex-

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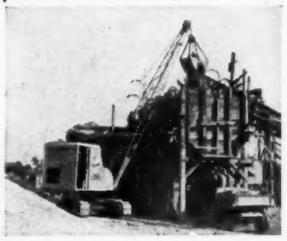

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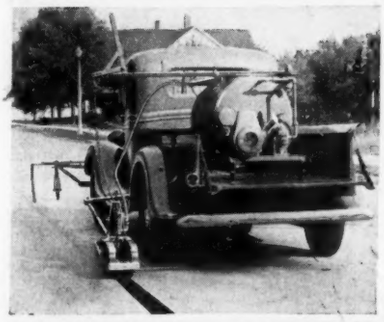

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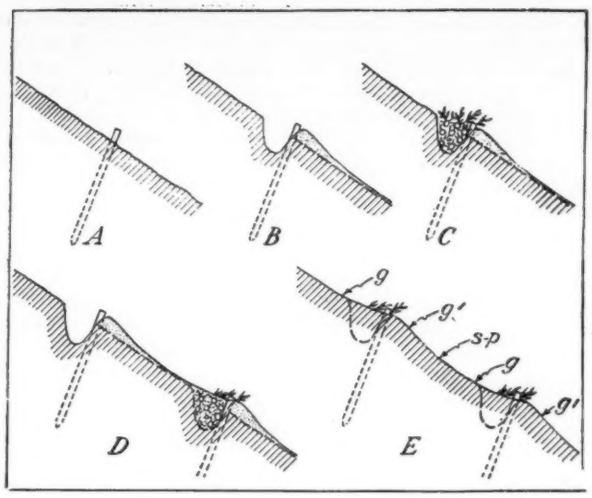
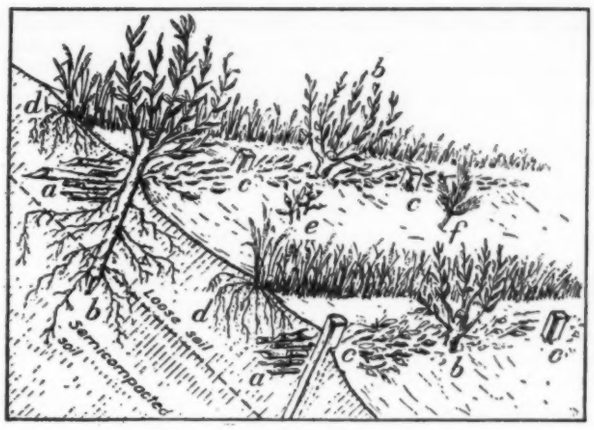




Left, steps in contour trenching, wattling and sowing cereals; right, how the soil is held in place.

posed surface and the new fill. Trenches should be deeper or closer together and stakes larger and longer. Long stakes driven into the slope just above the slump aid in preventing further sloughing.

In no place is timely inspection and attention more important than in repair and erosion-proofing of culvert outfalls. The downhill location of such outlets makes them hard to see and necessitates climbing down the slopes to inspect them at close range.

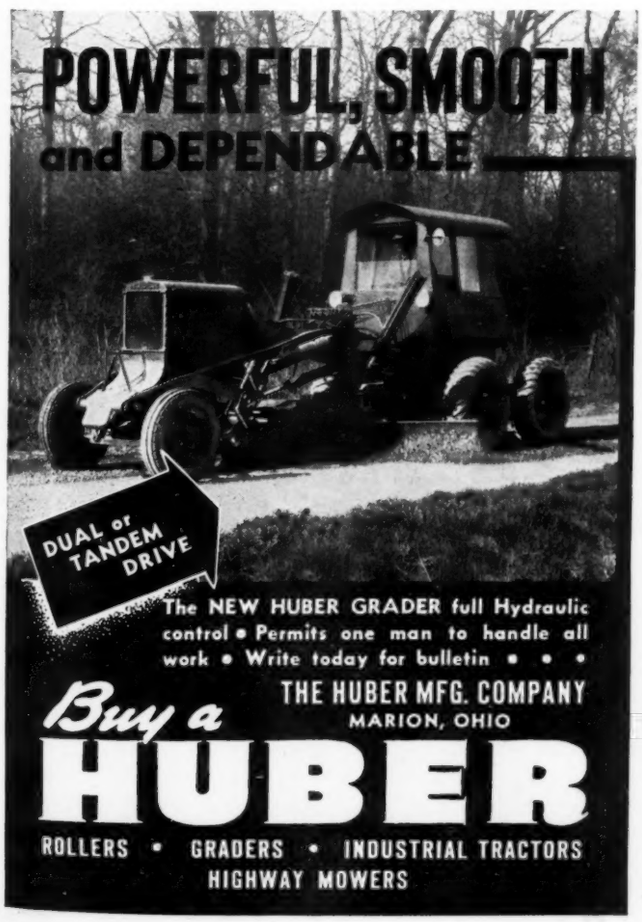
Structure Repair

This item covers normally the work involved in painting, repair and upkeep of bridge structures more than about 20 feet in span; the repair and maintenance of retaining walls; and the maintenance and repair of surfaces on timber bridge floors. In some states, this work is under the direction of the Bridge Department; in others it is a function of the general maintenance organization. In counties, there is normally no distinction, the maintenance engineer and his forces handling all such work.

General Information.—Bridge or structure maintenance differs from other maintenance in that prevention is an even more important part of the work. It is a major job to replace a failed bridge, and a costly one. Therefore, especial attention should be given to inspections aimed at keeping the structure in the best possible shape.

Aside from the structure itself, the approaches, the stream channel, and the substructure are important. These should be inspected regularly, both as a guide for upkeep and repair, and to keep acquainted with the needs of highway traffic.

In the inspection of a bridge, full notes should be made on such factors as the following, outlined in the Ohio Field and Office Manual: Is it too narrow for the traffic it handles; is it used by pedestrians to any extent, and if so, are they subjected to an unusual or unreasonable traffic haz-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ard; does the bridge carry water or power lines, and are these a burden or do they damage the bridge?

In regard to the approaches, does alinement need improving, and can this be done at small expense; is the pavement smooth; have slabs or surface settled at the approach, leaving a bump; is the bridge pavement slippery in wet weather; is there an adequate guard rail, and is it properly placed and flared at the approach: are proper warning signs erected (as for narrow or one-way bridge, or poor alinement); if the bridge is paved with a rigid type pavement, are expansion joints in good shape and properly spaced?

Regarding the stream channel, are the banks washing or eroding; is the waterway opening too small, or too large; is the channel obstructed by brush or trees; or is the main thread of the stream so located as to be a hazard to the structure or the roadway?

Regarding the substructure, has there been any sliding, bulging or settling, or cracking of wingwalls or piers; is there any undermining of piers or abutments; are the tops of the wings cracked or broken by the expansion of the structure; is there any seepage through the walls; is there place for expansion of the pavement and of the structure; what is the condition of the pier, abutment and wingwall material; is the drainage from the bridge causing wash or other damage?

Does water stand on the floor of the bridge after a rain; are the scuppers working properly, and are they properly located? If water stands on the floor, is it because the scuppers are improperly placed or due to an uneven surface? Is the floor slippery in wet weather?

Every structure should be inspected at least once a year by the principal engineer; by the district engineer or supervisor every 3 to 6 months, and especially in the fall and spring; and by the maintenance foreman or patrolman every month. A record of the inspection should be kept, which may be less complete in the case of the monthly inspection. The record of the annual inspection should be full. A standard form of report is desirable, covering the above points, and perhaps others. In addition to the annual inspection, inspections should be made after unusual floods or other occurrences. Also, in the case of old, narrow or inadequate bridges, more frequent inspections are desirable.

Steel Structures.—Inspections of steel bridges, in addition to the factors already enumerated, should cover the condition of the paint; if the trusses, beams and girders are in line; if any members of the bridge have been damaged by collision or accident; if any of the bridge members show signs of overloading; if there is the required space available for expansion; if the bridge vibrates excessively under heavy loads; the condition of the floor beams and of the joints and hangers.

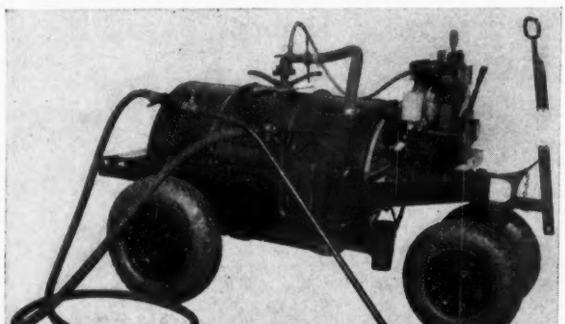
A steel bridge must have plenty of space in which to expand and contract as the temperature changes and the expansion devices (rollers, rockers or sliding plates) must be kept clean, greased (about once a year), and in shape to work as they were designed to do. Improperly placed or operating drainage devices may cause damage by discharging water onto some of the members of the bridge or by retaining water in contact with the steel.

Painting of a bridge must be preceded by satisfactory cleaning to remove all scale and rust. Hand methods of cleaning are usually unsatisfactory, and a sand blast or other mechanical device is better. If in good shape, one coat of paint may be sufficient, and this may be black with white or aluminum on the end posts. If two or more coats of paint are required, the base coat should generally be red or blue lead. Paint may be applied by hand or by spray methods, but the latter will be more economical in most cases.

Concrete Bridges.—According to the Ohio Field and Office Manual, concrete structures require particular attention in regard to leaky joints, drainage and expansion. Surface drainage facilities must be kept in proper condition. In order to prevent injury from expansion, sliding plates must function properly and freely. Cracks indicate settlement, and their cause should be determined. Inspection should cover the following points:

Disintegration of the concrete; water leaking through the structure; leakage around and through expansion joints; space for expansion; exposure of any reinforcing bars; condition of premolded expansion joint material; cracks in the concrete; condition of railing; and condition of floor or roadway surface.

DO ONE JOB WELL
MAINTENANCE



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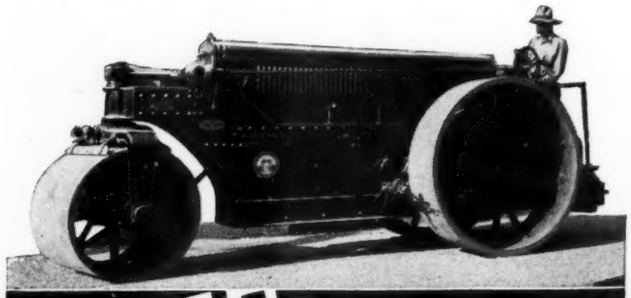

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Timber Bridges.—The items of work necessary for maintenance of timber bridges will include: Repairs and renewals to the deck or traveled way, and to the stringers, caps, posts and bracing; piling renewal, where used; creosote treatment, as needed; tightening bolts; and miscellaneous minor repairs. Special attention should be given to protection against decay, which means adequate and proper drainage and the removal of debris that may hold moisture against any portion of the structure. Creosoted members that check or split should be re-treated by hand painting. Creosoted floors are often dangerously slippery and also a fire hazard.

Creosoting of the bridge members—i.e., the woodwork of the bridge—every 6 to 10 years, by spraying with creosote oil, has been reported to increase the life of the bridge. The work should be done when the wood is thoroughly dry and, of course, in dry weather.

Inspection should cover decay in bridge members, especially at connections; condition of bearing blocks; condition of floors, beams and joists, especially the end joists which rest on the abutments or piers; the condition of the fasteners holding the floor to the joists; checking or splitting of members; condition of the floor; and conditions tending to cause a fire hazard.

Fire Hazard.—There is always a fire hazard with wooden bridges or bridges with wooden floors. Even though this is not often a cause of damage, precautions should be taken to prevent it. Piles of debris that have been deposited by floods against the abutments or supports should be removed, as when dry these are a decided fire hazard. Brush and weeds should be kept well trimmed for some distance from the bridge, so that a fire starting along the roadside will not be able to spread to the bridge. Leaves or other objects that blow into or against the bridge are also possibilities for fire. Weeds or brush growing under the bridge, should be kept cut. In patching bituminous mats or timber bridges or floors, it is best to leave the heating kettle along the road and off the bridge.

Bridge Approaches.—The approach to a bridge should not be dusty or slippery; if dusty, a bituminous or calcium chloride treatment should be given for 100 feet or more back from the end of the bridge; if slippery, a suitable corrective treatment is needed. A guard rail should be placed to guide vehicles onto the bridge; and this guard rail should connect closely with the hub-guard of the bridge. The guard should be substantial and the hub guard should be strong enough to deflect vehicles back into the roadway. One panel, of the guard rail preferably should be a continuation of the hub guard, which should be 15 to 17 ins. above the floor level. Bridge approaches are safer if outlined with a row of reflector buttons, on both ends and at each side.

There should, of course, be no bump or hollow at either end of the bridge. On gravel roads, there is a tendency for a drag or grader to deposit some material at the bridge when the blades are raised to pass over the bridge, which tendency can be counteracted by crossing to the left side of the bridge at every alternate pass of the drag or grader. Bituminous pavements or surfaces can be built up to the desired level, or if too high, cut down and replaced; concrete pavements that are too low can be mud-jacked. With the hard-surfaced pavements, a bump is unusual; settlement is more likely.

Wash and Undermining.—Unusual floods, obstructions in the stream that divert the current to new channels, and an inadequate waterway, are the principal causes of undermining, which may be directed against a pier or an abutment. Each case is an individual study, and the remedy first tried may not be successful. Therefore, after obstructions have been removed, frequent inspections should be made to determine if this has corrected the trouble or if the channel has been straightened, to note if erosion no longer occurs. A flood may so change the bed of the stream that the current follows new channels, and considerable work may be needed to protect the bridge against damage.

Walls may be built, riprap protection placed, steel sheet piling driven, large stones or lean concrete in bags placed to divert the current, or other measures taken. The use of sheet piling, with concrete between the piling and the abutment or pier, is almost always effective. Placement of stone fill is often effective in changing the course of the current.

General.—In repainting a bridge, the date that the work was done should be marked plainly on the bridge in some fairly conspicuous place; and, of course, an office record should be kept of the date, kind of paint used, method of cleaning, method of applying the paint, and other pertinent factors.

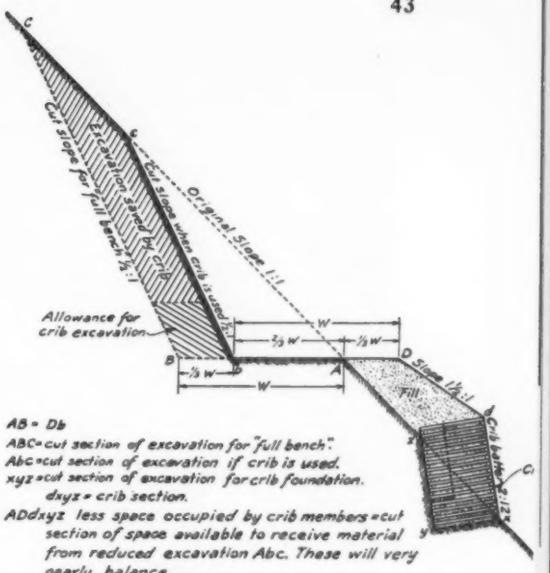
All bridges that have a capacity less than ten tons (or some other local standard) should be marked with a prominent sign indicating its safe load capacity. Such signs should be kept in legible condition.

All abandoned bridges or bridge approaches should be properly barricaded to prevent their use, whether the bridge is in place or not. Where because of relocation, abandoned steel bridges are left standing (perhaps to be moved to another location later), the floor, if of timber, should be removed to prevent fire, which may ruin the bridge, the ends should be strongly barricaded, and proper warning signs erected and maintained.

Retaining Walls

Use in Highway Work.—Retaining walls are used for holding back fills to prevent slips or slides, to afford extra width to the road without considerable added cut and fill, to protect against stream wash, and to prevent encroachment on private property by fills or in making cuts.

Walls may be of the crib type, of metal, reinforced concrete or even timber; or of concrete, plain or reinforced, or masonry. Crib type walls are generally cheaper and fully as satisfactory; also simpler to construct.


Original Slope 1:1
Allowance for crib excavation
Fill
AB = Db
ABC = cut section of excavation for "full bench".
Abc = cut section of excavation if crib is used.
xyz = cut section of excavation for crib foundation.
dxyz = crib section.
ADdxyz less space occupied by crib members = cut section of space available to receive material from reduced excavation Abc. These will very nearly balance.
bBCc − xyz = saving in excavation.

Use of cribs on side hill cut and fill on steep slope reduce excavation.

The outer or exposed part of the retaining wall is known as the face or front; and the side that is in contact with the fill is the back. The base is called the foot; the toe is the front or outer edge of the base; and the heel is the inner or back edge of the base.

The surface of the fill behind the wall may be level, or may slope upward or downward from the wall. When it slopes upward, that part above the level of the top of the wall is called the surcharge. A surcharge greatly increases the pressure on the wall, and the base must be made correspondingly wider. A load, as a truck on a road surface above a retaining wall, acts as a surcharge.

It is not desirable to attempt to lay down arbitrary rules for the construction of a retaining wall, especially as regards the base width and its relation to height. Much depends upon the character of the material to be retained, its weight and angle of repose; the character of the footing; and whether or not there is a surcharge. The manufacturers of metal cribbing can and will furnish reliable information regarding design and construction. Most highway departments have standards of construction for concrete and masonry walls.

Drainage should be provided behind tight walls, as those of concrete or of stone laid in mortar; crib walls provide their own drainage.

Properly designed and constructed retaining walls require little or no maintenance. If improperly designed, or if the footing is inadequate, the wall will fail, and little can be done except replace or, in the case of crib walls, reconstruct them. Regular inspection is desirable; attention should be paid to raveling of dry rock walls, to keeping weep holes open, and to the appearance of cracks or other indications of failure.

Retaining walls have an especial value in widening roads, in preventing slips or slides from cut slopes, in holding overcast material on steep slopes, and in supporting shoulders on steep slopes or the toe of fills on the lower side.

Galion motor grader on maintenance work

Plant and Equipment

The activities under this division are those that include the work and administration necessary in connection with the equipment owned by or assigned to the maintenance forces. This will include, in most cases, small tools, barrier and work signs, equipment for highway construction and maintenance, buildings owned or operated by the maintenance forces, lands, and other facilities, as gravel or sand pits and quarries.

The operation of trucks, tractors, graders, power shovels, and other equipment used in this work, is normally covered by detailed directions issued by the maintenance engineer or superintendent. Such directions often cover the speed of operation, the methods of handling equipment, safety factors in operation, and policies in regard to repairs and overhauls; also, methods of obtaining supplies and repair parts; storage; standard equipment for each unit; stopping and parking of equipment on hills and curves; the proper use of hand signals; what steps to take in case of accidents involving equipment; and many other items. The Maintenance Departments of Virginia and Montana have an excellent set of detailed directions covering these factors.

Equipment should be removed from the highway and placed outside of the ditch line, if possible, for overnight storage. If not possible, it should be parked so as to interfere as little with traffic as possible, and protected by red lights. Equipment not in use should not be left where anyone can run into it, or where vandals may damage it. On equipment handling bituminous material, a fire extinguisher and a shovel should be permanent fixtures.

Small Tools, Work Barriers and Signs.—Small tools, such as picks, shovels, hoes and rakes, should be properly marked to indicate ownership. A record system is necessary in order to place responsibility for loss. This is generally done by checking out to each gang, the required number of each of the tools and by inventory from time to time to insure that each gang has the number of each that it is expected to have. Tools that are worn out and need replacement, are exchanged for new or repaired tools. A repair shop is usually provided, or arrangements made with a shop having the proper facilities, to sharpen picks, replace broken shovel or hoe handles, sharpen drills, and carry on similar needed work.

There does not seem to be a fixed general policy in regard to the small tools to be carried by a maintenance gang, as so many shovels and so many picks per unit of 5 or 10 men. In part, this is due to the fact that conditions vary greatly, not only from state to state and from season to season, but from section to section of any state, or in many cases in various sections of the same country. Local experience can fix these requirements.

Warning signs should always be placed on the highway when the maintenance forces are working on the traveled way or on the shoulders, or when the work being done requires that men or equipment be on the surface or the shoulders from time to time. "Men Working" signs should be placed on the right shoulder of the road; such signs should carry a red flag and should be placed in a clearly visible location, care being taken to have a contrasting background behind the sign. The signs should be placed from 300 to 600 feet in advance of the place the men are working, depending upon sight conditions and other factors. They should be removed as soon as work is over for the day; they should be removed during the lunch period; and at any other time when work ceases for as much as 15 minutes.

Placement of a sign or barricade in the daytime, alongside of a guard rail, greatly reduces its visibility, and especial care should be taken to make the sign and barricade easy to see and read.

Wherever the work is of such nature that one-way traffic must be maintained, a well-constructed sign and barricade should be placed at least 600 feet in advance of the danger area, and wherever else they appear to be needed. For one-way traffic, a flagman is usually required. Barricades should be well lighted at night—with a red light to warn of danger and with a white light to permit motorists to read the sign. If possible, plan the work so there will be room for two-way traffic at night.

Care should also be taken that torches or lanterns are clean, filled, and of sufficient capacity to burn all night, even under most adverse weather conditions. The foreman in charge of the work is usually held responsible for inspecting personally, the placing and lighting of lanterns.

Storage of Equipment.—A safe place, protected from the weather, should be provided for storing all equipment when not in use. A modern garage is an excellent means of conserving the investment in maintenance and construction equipment. A place for making needed repairs is necessary. Small tools, maintenance equipment, barriers and signs, trucks, tractors, rollers, etc., should be provided for, each having a place and being kept in that place under the direction of the garage foreman.

The April installment will include Handling and Storing Materials and Maintenance of Untreated Surfaces.

Liability for Curb Box Above Grade

Action was brought against a water company for injuries to a pedestrian whose foot was caught in a curb box installed by the company and which projected somewhat above the general surface of the sidewalk. The New Jersey Supreme Court (Folk v. Hackensack Water Co., 2 Atl. 324) found that the company had set the box at the sidewalk level as furnished by the city engineer, there being then no sidewalk. When the sidewalk was subsequently laid by the city, it was laid at the proper level and flush with the top of the curb box. Since that time the sidewalk had settled due to the condition of the soil, so that the curb box protruded slightly above the sidewalk level, which at this point was next a vacant lot owned by the city. It was held plaintiff was not entitled to recover and judgment for plaintiff was reversed. The water company was not the owner or in control of the curb box, which was the property of the town; the company was in no way responsible for the settling of the sidewalk or under any duty of maintenance or care in regard to the situation existing.

Paving and Sewerage Problems of the N. Y. World's Fair

(Continued from page 11)

Fair highway projects submitted to the Board of Estimate by S. Meredith Strong, Superintendent of Highways for the Borough of Queens, who requested $400,000 for the purchase of materials and the rental of equipment—labor and supervision to be furnished by the WPA—for the construction of a 70-foot highway to parallel the Grand Central Parkway from Queens Boulevard to the Nassau County line, a distance of 7.3 miles. The plans called for two 32.5 foot roadways separated by a 5-foot mall or 237,084 square yards of 2-inch asphaltic concrete laid on a 6-inch broken stone base, with 116,000 feet of concrete curb, 115 seepage basins and 12 basin manholes. The turnpike is to relieve the traffic congestion on the Parkway which, on a summer Sunday, may reach as many as a million cars in twenty-four hours.

Woodhaven Boulevard, on the other hand, was designed to take traffic away from the Fair Grounds, south to the Rockaways. It underpasses two dangerous railway crossings, replacing a narrow twisting lane with a 120-foot highway, divided into two 50-foot roadways by a 10-foot mall, between Queens Boulevard and Forest Park, a distance of 2.4 miles.

But these are only two of the more than seventy World's Fair paving and repaving projects which called for the widening of all county roads leading to and from the Fair Grounds, laying 305 blocks of asphaltic concrete and 28 miles of residential paving. Roads that are to serve as main routes during and after the Fair are paved with a base course of 1½-inch stone rolled to a compacted thickness of 6 inches. All voids are then filled with screenings or sand and the roadway re-rolled. On this base a hot plant-mix of bituminous concrete is laid in one course to a thickness of two inches, rolled and dusted with cement. The residential pavement for side streets consists of two courses of asphalt-penetrated cinders rolled to a compacted thickness of 3 inches.

Surveys, plans and specifications for all these various projects were prepared by WPA engineers and draftsmen assigned to the Queens Bureau of Highways, while the actual pick and shovel work was done by some 5,000 relief workers—clerks, butchers, shoemakers, printers, bookkeepers, chauffeurs, motormen and upholsterers—from 18 to 65 years of age, certified by the Home Relief Bureau of the Department of Welfare of the City of New York as physically capable of a hard day's work.

The cost? Roughly $6,000,000—half of which was contributed by the city for materials and the rent of road rollers, steam shovels, dump trucks, bulldozers, graders, cement mixers and drills.

Tar Soil Stabilization

(Continued from page 15)

A tack coat of one-quarter of a gallon per square yard was applied to the surface and lightly covered with soil which was hand broomed to a uniform spread.

On one occasion a considerable length of mix was permitted to dry out due to a tractor breakdown. When compaction could be continued, additional water was added, and the material was again mixed with a blade grader, spread, and compacted with no difficulties or defects being apparent.

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Road-Mix Method

Before the entire program, which ultimately amounted to 40,000 square yards, could be completed, it was necessary to return the rented paver. Road-mix methods were resorted to, with excellent results.

With this change from a traveling plant mix to road mix methods, it was necessary to compute the required tar on a square yard per inch compacted basis. With some coarse aggregate present, it was estimated from laboratory studies that the compacted mixture would have a density of 125 pounds per cubic foot.

Assuming 72 per cent of soil passing a No. 10 sieve—as was the case on one street—the recommended six per cent of tar is equivalent to 0.39 gallon per square yard per inch of compacted depth, calculated by an approximate formula as follows:

$$125 \times \frac{72}{100} \times \frac{6}{100} \times \frac{9}{12} \times \frac{1}{9.8} = 0.39$$

In which 125 = weight per cubic foot of compacted mix; 72% = material passing No. 10 sieve; 6/100 = 6 pounds of tar to 100 pounds of soil; 9/12 = square feet per square yard, one foot in inches, and 9.8 = weight of a gallon of tar.

Having the percentage of material passing the No. 10 sieve for each street, the amount of tar required per square yard per inch of compacted depth was computed for each street to be constructed by the road-mix method.

The streets were loosened to a depth of six inches and tar was applied, reducing the quantity computed per square yard by one-fourth of a gallon, reserved for the tack coat. It has been found that about half the amount of tar used can be considered as moisture in determining the amount of moisture necessary for proper consolidation. Any deficiency must be supplied by the addition of water. Since the soil contained approximately seven per cent of moisture and about four per cent of tar was used, it was necessary to add very little water to bring it up to ten per cent.

The tar was applied to the loosened soil in convenient increments and mixed with a power grader. When spread to proper cross section, the mix was tamped with a sheep's-foot roller. The blade grader was kept in continuous operation during the rolling. On completion of tamping, the surface was bladed to a smooth finish and rolled with a ten-ton roller.

A tack coat of one-quarter of a gallon per square yard of the same grade of tar as used in the mix was applied to the surface and lightly covered with soil, broomed to a uniform spread, and opened to traffic.

Surface Treatment

When a sufficient yardage of surface had been completed and cured to utilize a tank car of material, the base was given a surface treatment of one-third of a gallon per square yard of Tarvia A, heavy grade, (a hot surface-treatment tar, having a float test of from 150 to 210 seconds at 32°C). Before this application the streets were thoroughly broomed to remove the excess soil cover on the tack coat. (It was unnecessary to apply a prime coat of light tar as the tack coat provided a clean tar surface for the application of the surface treatment of heavy tar.)

The Tarvia A was covered with about 30 pounds per square yard of crushed slag, ranging in size from ¾" to ⅜", broomed to a uniform spread, and rolled. It is expected that this surface will be given a seal coat next year with a finer sized cover.

The project was sponsored by the City of Albertville, A. B. Hooper, Mayor. M. A. Tardy is W.P.A. Area Engineer, and Gilbert Hart was Resident Engineer.

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When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 52 & 53

Keeping Up With New Equipment

Roller, Harrow and Broom Now on "99" A-W Grader

The Austin-Western Road Machinery Co., Aurora, Illinois, have announced three new attachments for the all-wheel drive and steer "99" Motor Grader. These will be shown at the Road Show. The first is a rear-mounted roller that is raised and lowered by hydraulic power. It measures 6 feet long by 30 inches in diameter and is built in three sections for operation as a 2, 4 or 6 foot roller as desired. Each section, which may be filled with water, provides an estimated compression of 197, 252, or 470 lbs. per lineal inch, with a 6, 4 and 2 foot width roll respectively. When the roller operates, the rear drive wheels of the motor grader are elevated above the ground, but there is ample traction and power in the front wheels to meet all rolling requirements.

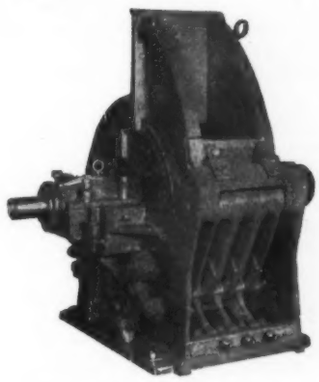
The second is a two-gang disc harrow for front-end attachment, ahead of the wheels; it is operated hydraulically and can be lowered to a maximum depth of 6 inches below the front tires. It consists of eighteen, 20-inch diameter discs spaced 4 inches apart, arranged in inverted V formation so that material travels toward the center from each side. Harrow covers a maximum width of 70 inches; each section has three angle adjustments of 5°, 10° and 15°.

The third attachment is a power-driven, rotary broom mounted just ahead of the blade; it is raised and lowered hydraulically from the cab and does a thorough job of cleaning the road surface. It measures 8 feet long by 26 inches in diameter and is driven by a special hydraulic motor.

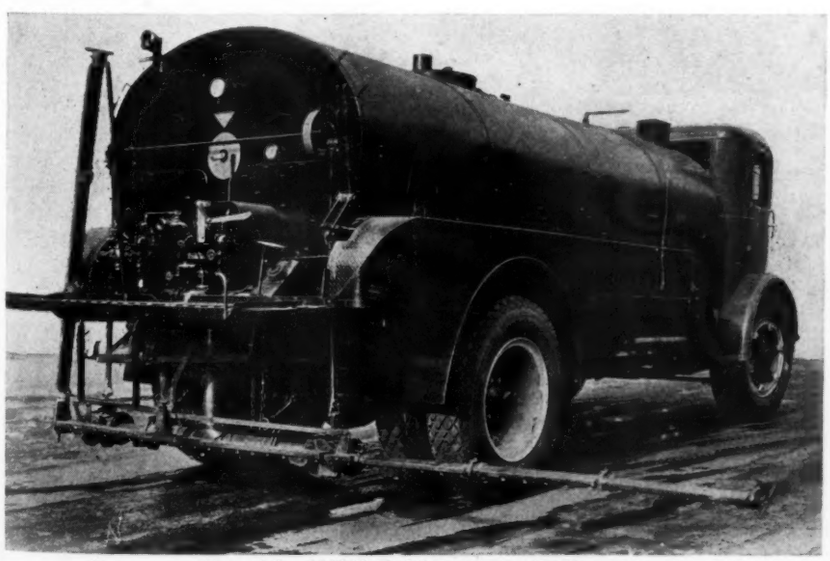
Austin-Western "99" grader now available with roller, harrow and broom

Garbage Hogs for Grinding Garbage

Mitts & Merrill, Saginaw, Mich., manufacture garbage disintegrators or shredders, often termed "hogs." These are used for producing a fine and uniformly ground product from city garbage. The No. 12-CR B is the smaller machine, designed for small and medium size cities for grinding garbage; this will take 3 tons per hour and requires about 25 h.p. Larger units are available to handle up to 24 tons per hour and requiring up to 150 hp. Data sheet is available on request.



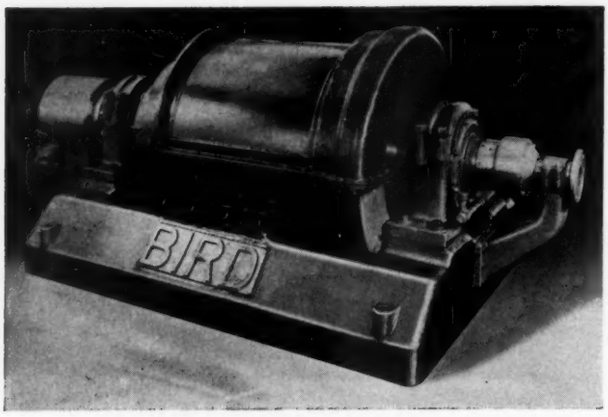
Mitts and Merrill grinders for shredding garbage.



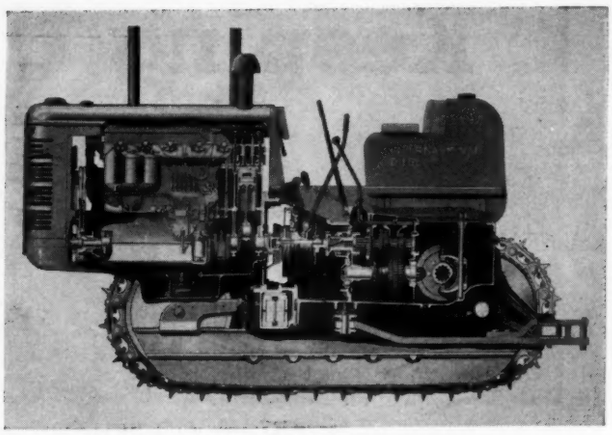
One of the 1939 Brokol bituminous distributors

Brokol Bituminous Distributor for 1939

The new 1939 models of the Brokol bituminous distributors have adjustable spray bars, non-drip, which will spray from all or any portion of their 26-ft. length. Automatic "suck-back" prevents dripping. Bars will raise or lower, either from the cab or from the rear platform, or both, by means of a ratchet raising device which holds the bars in desired position. A tipping device permits material to flow to a double suction sump when the bars are raised. The photo shows a Brokol distributor which is one of a fleet working for Barrett Paving Co., Trenton, N. J. These distributors are made by the Brokol Mfg. Co., Inc., Newark, N. J. Catalog on request.



The Bird sludge centrifuge



The new 80-hp. diesel International tractor

Bird Sludge Centrifuge

The Bird solid bowl centrifugal machine for dewatering solids is made in three sizes, with bowl diameters and lengths of 18x28, 36x50 and 36x72 inches. On raw sludge dewatering in Chicago, the 18-inch machine handled 220 pounds dry solids per hour with 68% moisture. The 36-inch units should handle 4 to 8 times as much. Tests are now running on handling digested sludge. Cake is discharged continuously. Rotative speeds are 2000 rpm on the 18-inch and 1400 rpm on the 36-inch. This centrifuge is handled by Dorr Co., 570 Lexington Ave., N. Y., who will supply further data on request.

Edge Protection for Tracings

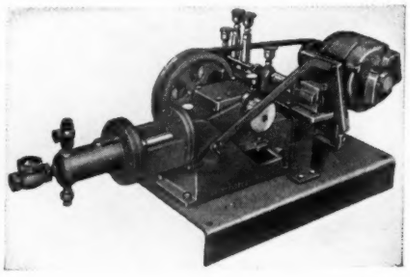
David White Co., 315 West Court St., Milwaukee, Wisc., has developed an edging machine and tape for protecting tracings, drawings, photostats, prints, etc. The tape is white, opaque, acetate fiber; tracing edges with it can be run through a blueprint machine without adhering to the glass. The sample we have is a nice job. Fuller information from the manufacturer.

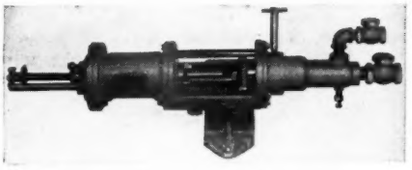
A Comfort Seat for Truck Drivers

A new seat has been devised which can be installed in any truck, regardless of make or model, and which, being easily removable, can be transferred from truck to truck. This seat, the Syncro-Seat, does away with jolts and jars; the seat movement can be timed instantly for truck speed, road conditions and driver weight. The increased efficiency that results from driver comfort is often considerable. Full information from the the Car State Products Co., Royal Oak, Mich.

Proportioneers' Amm-O-Feeder

Proportioneers, 9 Codding St., Providence, R. I., have developed the Amm-O-Feeder, which consists of an electrically or hydraulically operated pump for using aqua ammonia for water treatment. It will feed the proper dosage of ammonia to flows of a few gallons per minute up to 50 million gallons per day. It will inject against pressures up to 200 pounds. Installation diagram and data on feeding sent on request.





Proportioneers Amm-O-Feeders

The New International Diesel Tractor

The Model TD-18 Diesel six-cylinder tractor is the largest and latest of the International crawler-tractor line. The maximum belt horsepower is approximately 80 and maximum drawbar horsepower is 70, both figures being corrected to sea level and temperature.

As is the case with other International Diesels, the TD-18 starts on gasoline and, after a minute or less of operation, shifts to full Diesel operation. A conventional automotive-type electric starter is regular equipment, and with it the engine is started from the seat, regardless of weather.

The tractor has six forward and two reverse speeds, as follows (miles per hour at rated engine speed); Low gear, 1½; second, 2; third, 2½; fourth, 3¼; fifth, 4⅝; high, 5¾; low reverse, 1½; and high reverse, 3¼. Weight is about 22,000 pounds.

The six-cylinder engine is of four-cycle, full Deisel type. The bore is 4¾ inches and stroke, 6½ inches.

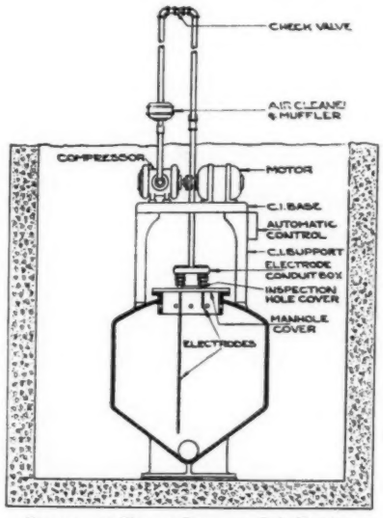
Left: This Traficounter is as necessary to the highway engineer as meters to the sanitary engineer. Operated by a roadstrip, it provides real counting—total, directional, turning. Information on traffic counting from Paver-Sills Co., 4101 Ravenswood Ave., Chicago, Ill.

Right: This is the new Lorain-79, 1½-yd. convertible unit, latest development of Thew Shovel Co., Lorain, O.

Shipping HTH by plane to Chile earthquake area

Shone "Package" Sewage Lift Station

The Shone pneumatic sewage ejector can now be obtained in a self-contained unit, with the Yeomans motor driven rotary compressor and control equipment,



Section of Shone Sewage Lift Station

all mounted on top of the ejector receiver. This is especially designed for underground lift stations and has the advantages that there are no floats, bells, screens, air storage tank, sump or collecting well, or moving parts. A circular gives specifications, and information on how to select the proper unit. Write Yeomans Brothers Co., 1409 Dayton St., Chicago, Ill. This unit is suitable for capacities up to 100 gpm.

American Public Health Association

The 68th annual meeting of this association will be held in Pittsburgh, Pa., October 17 to 20, 1939, with headquarters at the William Penn Hotel. Detail program will be announced later.

C. H. Olmstead, consulting engineer of the General Tarvia Department, the Barrett Co., died in Washington on February 1. Mr. Olmstead had a long experience in highway engineering, with the New York State Highway Department, with the Tennessee State Highway Department and with the Barrett Co., since 1928.

New Reflector Sign Material

Mir-O-Ray, a new development in processed metals and foils, recently introduced by the Mir-O-Ray Division of the Arcturus Radio Tube Company, Newark, New Jersey, is specially adaptable for highway and municipal signs, railway signals, house numbers, etc. It is supplied in sheets, strips, letters, numbers and characters, and is decidedly economical to use.

Samples and literature will gladly be sent upon request to the Arcturus Radio Tube Company, Newark, N. J.

Arthur E. Schuh, a physical chemist formerly with the Bell Telephone Laboratories, has been appointed Director of Research of the U. S. Pipe & Foundry Co.

Florida Section AWWA

The thirteenth annual meeting of the Florida Section, AWWA, will be held at the Alcazar Hotel, Miami, Florida, May 4, 5 and 6. J. R. Hoy, Hilderbrandt Bldg., Jacksonville, Fla., is secretary.

Kentucky-Tennessee AWWA

The annual convention of this section of the AWWA will be held at the Peabody Hotel, Memphis, Tenn., April 10-12, 1939. Howard D. Schmidt, 420 Sixth Ave., North, Nashville, Tenn., is secretary-treasurer.

Lynchburg Foundry Co. Personnel Changes

The following changes have been announced at Lynchburg Foundry Co.: John T. Woodson, formerly sales manager of the pipe division, has been appointed General Sales Manager; W. R. Odor, formerly manager of the Chicago Office, returns to Lynchburg as sales manager of the Pipe Division; John C. Barksdale, formerly manager of the New York Office, succeeds to the management of the Chicago Office; Miss Agnes Moran, long connected with the New York Office, succeeds Mr. Barksdale as manager there.

John T. Woodson

Index to ADVERTISEMENTS

Activated Alum Corp.	50
Alvord, Burdick & Howson	49
Armco Culvert Mfrs. Assn.	6
Ashdown, Williams & Co.	49
Barber-Greene Co.	8
Barrett Co., The	37
Black & Veatch	49
Browne, Floyd G.	49
Buffalo-Springfield Roller Co.	42
Burns & McDonnell Engr. Co.	49
Caird, James M.	49
Calcium Chloride Association	39
Cast Iron Pipe Research Assn.	2
C. H. & E. Mfg. Co.	26
Chevrolet Motor Div.	33
Cramer & Sons, Inc., Robert	49
Dow, A. W., Inc.	49
Everson Mfg. Co.	26
Fairbanks, Morse & Co.	4
Ford Meter Box Co.	26
Frink, Mfr., Carl H.	40
Fuller & McClintock	49
Galion Iron Works & Mfg. Co.	35
Goodyear Tire & Rubber Co.	5
Gorman-Rupp Co.	31
Greeley & Hansen	49
Green Co., Howard R.	49
Harrub Engineering Co.	49
Hill Associates, Nicholas S.	49
Huber Mfg. Co.	41
International Harvester Co.	3
Inertol Co.	31
Jaeger Machine Co.	41 & 27
Jefferson Hotel	26
Layne & Bowler, Inc.	45
Lock Joint Pipe Co.	25
Meili-Blumberg Corp.	40
Metcalf & Eddy	49
Morse Boulger Destructor Co.	46
Osgood Company	40
Pacific Flush Tank Co.	46
Philadelphian Hotel	50
Pirnie, Malcolm	49
Potter, Alexander	50
Proportioneers, Inc.	46
Quinn Wire & Iron Works	30
Raleigh Hotel	50
Robert & Co.	50
Roberts Filter Mfg. Co.	46
Russell & Axon Cons. Engrs., Inc.	50
Serviced Products Corp.	27
Simplex Valve & Meter Co.	30
Smith & Co., Gordon	54
Socony-Vacuum Oil Co., Inc.	55
South Bend Foundry Co.	50
Sterling Engine Co.	25
Tarrant Mfg. Co.	42
U. S. Pipe & Foundry Co.	29
Wallace & Tiernan Co., Inc.	Back Cover
Weston, L. A.	31
Whitman & Howard	50
Wiedeman & Singleton	50
Wilson Engr. Co.	50

Readers' Service Department

Below are described selected booklets, catalogs and data books of particular value to those engaged in public work.

These booklets are FREE. Write to the firm whose name is is given, mentioning PUBLIC WORKS, or to this magazine.

Construction Materials and Equipment

Air Compressor from Ford Parts

5. How you can convert an ordinary Ford model A or B motor into an air compressor for operating jackhammers, paving breakers, clay spaders, tampers, paint sprays, etc., is explained in a new bulletin just issued by Gordon Smith & Co., Desk G, 516—10th St., Bowling Green, Ky.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subject suggested by title.

36. "Wyandotte Calcium Chloride and its use in Portland Cement Concrete," a booklet covering the subject of curing concrete pavements, structures, etc., giving complete specifications for surface and integral curing. Published by the Michigan Alkali Co., 60 East 42d St., New York, N. Y.

Concrete Mixers

44. Catalog and prices of Concrete Mixers, both Tilting and Non-Tilt types, from 3½S to 56S sizes, The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Culverts

60. "In diameters up to 10 feet and larger . . ." just issued by the Armco Culvert Mfrs. Assn., tells a good deal about drainage problems and their solution. 32 pages about drainage and multi-plate culverts.

Dirt Moving Efficiency:

65. "Dirt Moving," is a new 32 page booklet illustrating the use of Trac Tractors as a source of money-making power for bulldozers, bullgraders, wheel scrapers, fresnos, graders, dump wagons, tampers, etc. 24 pages of action pictures, directions, etc. Sent promptly by International Harvester Co., 180 No. Michigan Ave., Chicago, Ill.

66. Where loading is done by hand, the Load Lugger, with your small truck, will cut costs tremendously. Simple, low in price. Especially adapted to city, county and town work. Complete details on request. Brooks Equipment & Mfg. Co., 56 Davenport Road, Knoxville. Tenn.

67. "Modern Methods of Moving Earth" is an 88-page illustrated book explaining earth moving by tractor power. Tells what types of equipment is most efficient for each class of work and includes estimated costs of the different methods on average jobs, short cuts in estimating, etc. Sent only to those having earth moving problems by Cleveland Tractor Co., 19,300 Euclid Ave., Cleveland, Ohio.

Finisher

78. A very complete, 36 page illustrated booklet on the Barber-Greene Tamping-Leveling Finisher explains its important features, principles of operation, types of jobs it handles and materials laid. Ask for catalog 879, Barber-Greene Co., 635 West Park Ave., Aurora, Ill.

Hose and Belting

87. Complete information on rubber hose and belting for all types of contracting and road building service. The Government Sales Department of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Mud-Jack Method

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and streets solves problems of that kind quickly and economically without the usual cost and time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Paving Materials, Bituminous

111. An excellent booklet issued by The Barrett Co., 40 Rector St., New York, N. Y., describes and illustrates the uses of each grade of Tarvia and Tarvialithic; 32 good illustrations.

Paving Materials, Brick

116. Recommended standard specifications for vitrified brick pavements and brick parking strips and gutters, as submitted to the American Society of Municipal Engineers. If you contemplate using brick for paving, you should have a set. National Paving Brick Ass'n, Washington, D. C.

Pumps

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

123. A new, 52 lb., midget, self-priming centrifugal pump which can be carried easily from job to job is described and illustrated in literature recently issued by Gorman-Rupp Co., Mansfield, Ohio.

124. 16-page illustrated bulletin, SP-37, describes and illustrates complete C. H. & E. line of self-priming centrifugal pumps from 1½" to 8", including lightweight models for easy portability. C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

Road Building and Maintenance

126. Action pictures show steps in road construction and maintenance, covering grading and ditching, rough grading, gravel and stone road construction, bituminous surfacing, fine grading and paving, summer and winter maintenance, municipal work and material handling, and illustrate Austin-Western equipment on such work. Ask for publication AD1655 Austin-Weston Road Machinery Co., Aurora, Ill.

127. Motor Patrol Graders for road maintenance, road widening and road building, a complete line offering choice of weight, power, final drive and special equipment to exactly fit the job. Action pictures and full details are in catalog 200 issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

Rollers

130. New bulletin describing in detail the new Huber Road Rollers will be sent promptly on request by the Huber Mfg Co., Marion, Ohio.

132. The NEW Buffalo - Springfield Special Three-Axle Rollers for all kinds of precision rolling, especially of bituminous materials either hot or cold, are described in an illustrated pamphlet just issued by the Buffalo-Springfield Roller Co., Springfield, Ohio.

Shovels, Cranes and Excavators

145. The Austin Badger, a new, fully convertible ½ yard crawler shovel, made by The Austin-Western Road Machinery Co., No. A-5 Aurora, Ill., is fully described and illustrated in their Bulletin No. AD-1683.

146. New catalog picturing the detailed construction of Osgood "Chief" power shovel and illustrating it as shovel, clamshell, dragline, crane and piledriver. Write The Osgood Co., Marion, Ohio, for your copy.

Soil Stabilization

150. "High-Service, Low Cost Roads" is one of the newer booklets using an effective combination of picture and text to set forth the principles and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated. 34 pages. Sent by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Street and Paving Maintenance

Asphalt Heaters

198. Illustrated manual No. 11 describes "Hotstuf," the master oil burning heater. The only heater with patented elevated melting chamber for Asphalt, Tar and all bitumens used in road and street construction and maintenance, roofing, water proofing, pipe coating, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Bituminous Materials

202. The maintenance of all types of roads and streets is the subject of this 52 page booklet which will be sent on request by The Barrett Co., 40 Rector Street, New York, N. Y.

Dust Control

210. "How to Maintain Roads with Dowflake" is a new 58 page illustrated booklet of information on stabilized road construction. Includes specifications and several pages of reference tables from an engineer's notebook. Issued by Dow Chemical Co., Midland, Mich.

211. A complete booklet on dust control titled, "Dust Control and Road Stabilization," describes the use of Columbia Calcium Chloride for dust control purposes and stabilization of roads. Sent on request by The Columbia Alkali Corp., Barberton, Ohio.

Jacking Culverts

260. No interruption to traffic, and substantial savings in construction costs are the main advantages secured by using the Armco jacking method to install conduits, drainage openings, and passageways under streets, highways and railroads. "The Armco Jacking Method," describing this modern means of construction and its many applications, will be sent upon request. by Armco Culvert Mfrs. Association, Middletown, Ohio. Ask for Catalog No. 7.

Pouring Pots

265. Full line of welded, screened and hooded pots, light, strong and accurately balanced, designed for maximum savings. Send for literature and prices to Tarrant Mfg. Co., 12 Maple Ave., Saratoga Springs, N. Y.

Sanders

270. Galion's new, inexpensive sander for quickly spreading sand, stone dust, cinders, chips, rock salt, calcium chloride, etc., is described and illustrated in a new circular which will be sent on request by Galion Iron Works & Mfg. Co., Galion, Ohio.